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Abitibi-Night Hawk Gold Area

By

C. W. KNIGHT, A. G. BURROWS, P. E. HOPKINS AND A. L. PARSONS

Larder Lake Gold Area

By

P. E. HOPKINS

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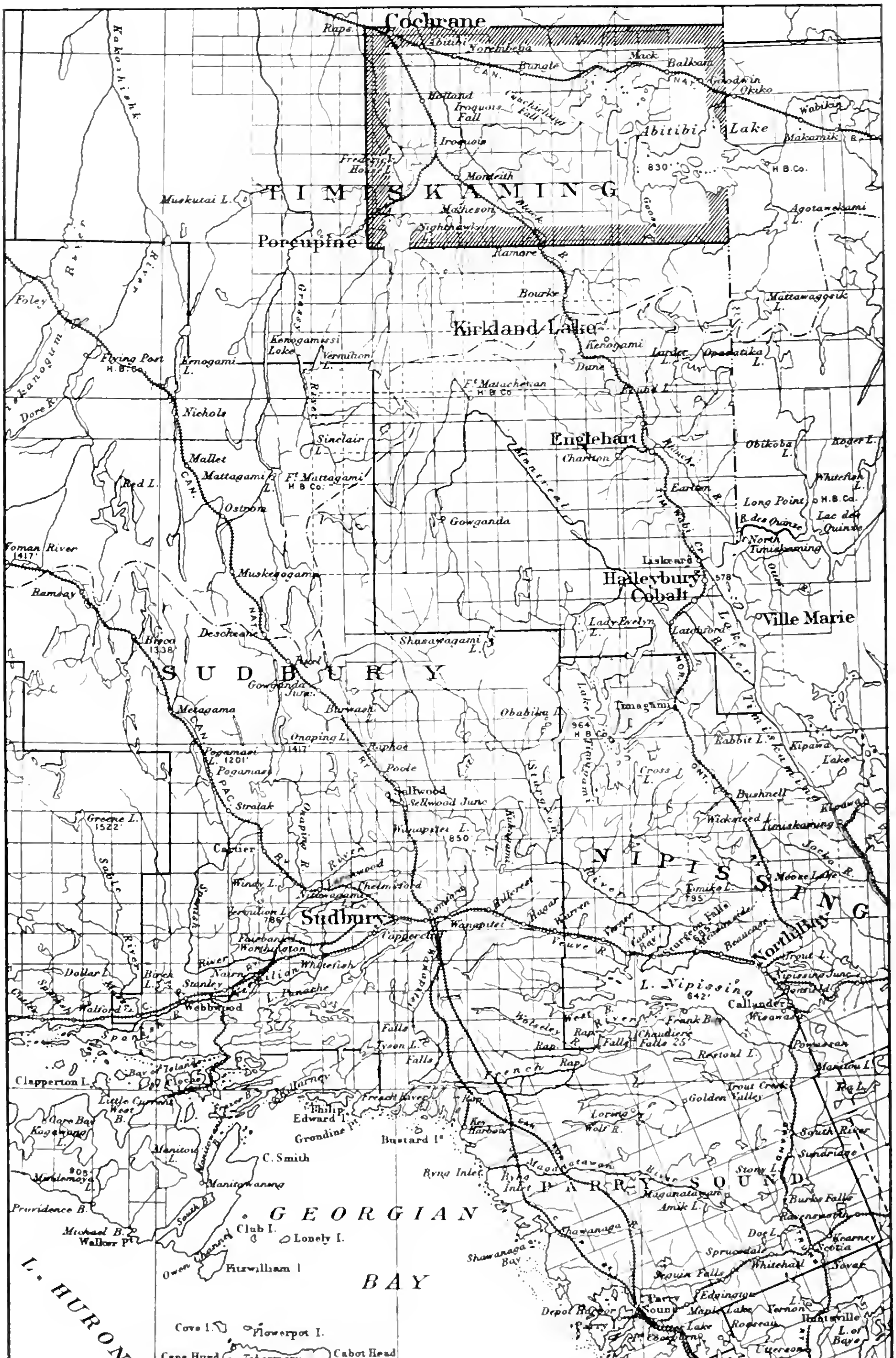


Key plan of part of Northern Ontario, scale 35 miles to the inch, indicating the location of area (hatched) embraced by geological map No. 28b accompanying this report.

ABITIBI-NIGHT HAWK GOLD AREA

District of Timiskaming

By C. W. Knight, A. G. Burrows, P. E. Hopkins and A. L. Parsons

Introduction

The search for gold in northeastern Ontario has revealed a widespread region in which Keewatin greenstones [1] of volcanic origin constitute the predominant rock. Prospectors have found by experience that gold-bearing quartz veins occur more abundantly in these ancient greenstones than in the vast stretches of granitic rocks which are so common in the Province of Ontario. It has been further discovered that, while gold deposits occur mainly in these greenstones, they are, at the same time, more or less closely associated with intrusions of acid porphyry or granite.

The greenstone areas of northeastern Ontario have already yielded great wealth and prosperity to the Province. Porcupine, which, although discovered in 1909, really only began to produce on a substantial scale in 1912, has yielded more than forty-four million dollars in gold up to the end of 1918, while Kirkland Lake, which lies about 60 miles southeast of Porcupine, has also produced important quantities of the precious metal.

In view, therefore, of the importance of having geological maps and reports of those parts of the country which are made up chiefly of greenstones, the geological staff of the Ontario Bureau of Mines, during the field season of 1918, devoted its attention to mapping an area which lies between Lake Abitibi and Night Hawk lake in the district of Timiskaming. Fig. 1. This area is immediately east and northeast of Porcupine, while to the south about 20 miles is the gold area of Kirkland lake.

Much of the area which we mapped, particularly that part at the east end, was practically a *terra incognita* in respect of geological information; but economically it was already of importance owing to the discovery a few years ago of the Croesus deposit in Munro township. At this mine some of the richest gold quartz ever found anywhere in the world was produced. Then, at the west end of the area, there is the well known Alexo nickel mine which has continued to yield quantities of nickel ore.

It may be added that in the area under consideration, and in nearby parts, there are immense forests of spruce and other pulpwood which have brought about the establishment of one of the most important pulp and paper industries in the world. The plant at Iroquois Falls, owned by the Abitibi Power and Paper Company, is said to be one of the largest of its kind anywhere.

[1] The word greenstone is here used in a very general sense to signify the most prominent type of ancient volcanic rocks occurring over wide areas. Usually near the ore deposits, as at Porcupine, such rocks have been largely altered to schists, and contain much secondary carbonate, sericite, and other minerals, the rocks having a light greenish or greyish colour.

Acknowledgments

During the field season we had the efficient assistance of the following gentlemen, namely: A. W. Carlyle, R. B. Crompton, J. F. Davidson, D. E. Kerr-Lawson, J. L. McCarthy, and A. B. McKechnie. We take pleasure in thanking these gentlemen for their interest in the work.

Wherever we went we were given hospitality by the mining companies and prospectors, and we acknowledge with thanks the many courtesies shown to us. We particularly desire to thank the Abitibi Power and Paper Company for their kindness at all times. Thanks are also due J. H. Hough, Mining Recorder, Matheson.

The excellent office work in preparing the geological maps and drawings accompanying the report was done by W. J. Bell and P. A. Jackson under the supervision of W. R. Rogers, topographer of the Bureau of Mines.

The chemical analyses and assays in connection with the report were made by Messrs. W. K. McNeill and T. E. Rothwell of the Provincial assay office.

Access to the Area

The westerly part is traversed by the Timiskaming and Northern Ontario railway, and the northerly part by the Canadian National railway. The most convenient station for the southwesterly part is Matheson, from which town there are roads to the mining camps in Munro, Beatty, Coulson and Hislop townships, and a good water route by the Black and Abitibi rivers to Rickard and adjoining townships.

The townships of Holloway and Harker, commonly called the Lightning River area, in the southeast part of the map-sheet, can be reached by a road from Matheson by way of the Croesus mine, a distance of about 40 miles, the last 15 of which are almost impassable in wet weather. A more convenient means of reaching the Lightning River area is by way of the National railway from Low Bush or La Reine stations. Low Bush is convenient to the townships south of Lower Lake Abitibi, and La Reine to those south of Upper Lake Abitibi. Gasoline boats and steamboats of the Abitibi Power and Paper Company make frequent trips from La Reine to the supply depots on the Mattawasagi (Teddy Bear) and Lightning rivers. From the forks, three miles south of the depot on Lightning river, there is a good trail six miles in length to the Howey-Cochenour-Willans claim in Holloway township.

Topography and Physiography

The area, with the exception of the southeast part of the map-sheet, is one vast undulating clay plain, broken here and there by depressions caused by the erosion of streams, and by a few prominent ridges or isolated hills of rock or sand. The plain lies on the James bay slope and has an altitude of 875 to 950 feet above sea level. It is now spoken of as a portion of the great clay belt of northern Ontario and is believed by A. P. Coleman to have once been the bottom of a vast glacial lake, named by him Ojibway. Jos. Keele, on the other hand, suggests that there were several old glacial lakes with intervening boulder clay and other glacial deposits. As stated later in the report, the writers regard Abitibi and

Fig. 2. Scene in the area south of Upper Lake Abitibi, looking southeasterly from Mount Smollet.

Fig. 3. Scene on Abitibi Lake, looking northeasterly from Mount Smollet.

Night Hawk lakes as having been once united, in which case there was at any rate a glacial lake of considerable size. The Frederick House river, rather than the Abitibi, occupies the principal valley above the junction of these two streams, supporting the contention of the writers that the outlet of both lakes may have been formerly by way of the Frederick House river. The drift is of glacial and recent age, and consists of boulder clay, lake clay, sand, gravel, peat and moss, which are described later under the Pleistocene.

The southeast part of this area is somewhat different from the undulating clay plain just described. Here the country is more rugged and the surface less regular, with a greater number of rocky ridges and hills. While lake clays and sands occur along the valleys of the rivers, most of the drift is boulder clay, sand and gravel of glacial origin.

Lying in the vast plain are three large lakes, viz: Abitibi, Night Hawk and Frederick House, with elevations of 879, 895 and 890 feet respectively above sea level. These lakes were much larger at one time, but are now shallow, averaging about 15 feet in depth. Since the lakes, rivers and streams are usually in clay the waters generally have a turbid appearance, due to finely suspended clayey particles. All the other lakes of the area are usually less than two miles in length, with the exception of Trollope and McDiarmid lakes, which are two and one-half miles long and have clear water. The small lakes and streams in the sandy areas such as Warden, Munro, McCool, Michaud and the east part of Garrison townships, have beautifully clear water, and often contain numerous small speckled trout. In the clay plains back from the rivers there are poorly drained areas containing large muskegs and peat bogs, which are also remnants of shallow lakes, and now the sources of many small streams. The area is drained by the Abitibi river and its many tributaries, of which Frederick House is the largest. These rivers have cut into the plain as much as 100 feet, the valleys being narrow and V-shaped. At a short distance from the rivers, usually under one-quarter of a mile, the general level of the plain is reached.

Rising above the drift plain in places are rocky ridges, the most conspicuous being the Ghost range, a prominent feature between the Ghost and Lightning rivers. The range is five miles long, east and west, and about one mile wide. It includes several prominent hills, the highest of which is near the Ghost river and is 1,540 feet above sea level, or 660 feet above lake Abitibi by aneroid. This is one of the highest hills in northern Ontario. Other high hills near the south shore of Abitibi lake are Mount Smollett, 1,315 feet, a conspicuous conical hill to the west of the Lightning river; Mount Goldsmith, 1,290 feet, just east of Lightning Point; and Burnt Hill, 1,295 feet, two miles south of the lake. There are also several prominent hills in the west part of Marriott township, in the vicinity of the III-mile post between Marriott and Holloway townships. Hills of lesser prominence occur in parts of Holloway. In Garrison township there is a conspicuous ridge of hornblende granite that occurs along the road from Matheson to Holloway township. Splendid views of the surrounding country are often obtained from the high hills.

An area of almost continuous rock exposure, 50 square miles in extent, occupies the southern portions of Coulson and Warden townships, the northeastern half

of Beatty township and most of Munro township. The three highest hills in this part are as follows: a basalt hill, 350 feet high, in lot 6, in the fifth concession of Munro; a diabase hill, 350 feet above the Shallow river, in lot 11, in the sixth concession of the same township, and a pillow lava hill, 300 feet high, having the appearance of an old volcanic cone, in lot 4, in the first concession of Coulson. The southern half of Knox township is mostly rock, the prominent peaks being in lot 3, in the second concession; lot 5, in the first concession; and lot 8 in the second concession. Part of the southwest corner of Bowman township is extremely rocky, some of the hills in lots 9, 10, 11 and 12 of the first concession being 300 or 400 feet high. Other isolated rocky peaks worthy of mention are the pillow lava hill projecting through the clay, 200 feet above Abitibi river, in lot 11, in the fifth concession of Teefy; the pillow lava hills rising 250 feet out of the sand in Calvert, from which one can see for miles across the vast plain; the pillow lava rising out of the sand in lot 4, in the first concession of Wilkie; and

Fig. 4—Perry lake, Michaud township.

the Keewatin hills in lot 6 in the sixth concession of Hislop, and lot 8 in the fourth concession of Guibord. From a rhyolite-andesite hill at the Alexo mine and from the hills in the southwest part of Bowman township one can see the town of Iroquois Falls and the rock and sand hills in Calvert township. There is considerable rock in both Clergue and Walker townships in the vicinity of Monteith.

Fish and Game

The excellent transportation facilities afforded by the Canadian National railway have resulted in a thriving fishing industry being established on Lake Abitibi. Whitefish, pickerel, pike and suckers, caught mostly in pound nets, are shipped in a fresh condition packed in ice to Montreal, Toronto and New York. While most of the rivers and lakes with turbid water are not suitable for fishing with rod or troll, the clear-water streams flowing through the rolling sand and gravel plains of Michaud, Garrison and other townships in the central part of the area contain small speckled trout, affording excellent rod fishing. Sturgeon are caught in the Frederick House and Abitibi rivers, but have not been reported as going above Couchiching falls into Abitibi lake.

Moose were seen by members of the party in various parts of the region, particularly in the marshy flats on the lower stretches of the Ghost and Lightning rivers. Red deer are reported in the vicinity of Matheson and on the sand plains of the central area. Bear are plentiful. Rabbits and partridge, that have been very scarce for the past few years, are again becoming numerous.

Forests and Forest Fires

The very severe forest fire of the 29th of July, 1916, that caused a disastrous loss of life, burned over 650 square miles of the south central part of the map sheet. The clean burns occured usually on the sandy and rocky portions and on the old partially-burned areas. For instance, in the sandy townships of Michaud and McCool, about 37 square miles have been burned so clean that there is no difficulty in travelling either on foot or in a wagon. The forest has been burned off

Fig. 5—Meadow in Holloway township, showing new growth of tamarac with spruce forest in background.

cleanly in the greater parts of the following townships: Michaud, McCool, Munro, Warden, Hislop, Beatty, and Carr; and in smaller parts of Garrison, Milligan, Guibord, Coulson, Wilkie, Bowman, Clergue, and Calvert townships. In many places the partially-burned trees have been blown over, making travelling in these parts exceedingly difficult. In Michaud and McCool about 23 square miles are of this character—"slash." Where the area has escaped the recent forest fires there is a mixed growth of timber of the usual varieties met with in northern Ontario. On the rolling clay ridges, particularly along the river banks, there are trees of good size, white spruce, birch, poplar, balm of Gilead, and balsam. Where the soil is sandy there are usually jack pine of fair size suitable for ties and lumber. Scattered here and there in the area are a few red and white pine. In many of the clay flats back from the rivers there are groves of black spruce, excellent for pulpwood. Cedar, ash and small soft maples are occasionally seen. There is a growth of young tamarac trees up to

20 feet in height in some of the swamps and beaver meadows, Fig. 5. These trees are in a flourishing condition, and if preserved from fire will replace the large tamaracs that were destroyed by an insect pest, the larch saw fly, some years ago. The area east of the Timiskaming and Northern Ontario Railway, along the Abitibi river and lakes, and along the Canadian National railway from Hughes to the Ontario-Quebec boundary, forms the timber reserve of the Abitibi Power and Paper Co. The company has already cut pulpwood in various parts of its reserve. During the summer and fall of 1918 large supply depots were established on the Mattawasagi (Teddy Bear) and Lightning rivers, Fig. 6, and the company had begun to cut pulpwood in the virgin area south of Upper Lake Abitibi.

The muskegs or peat bogs which occupy approximately three per cent. of the area are almost treeless, or contain small black spruce, an inch or so in diameter, which as the bog is left behind grade gradually into larger trees.

As a result of forest fires many of the surveyors' posts have, unfortunately, been destroyed.

Fig. 6—Pulpwood camp on Lightning river; Abitibi Power and Paper Company.

General Geology

The rocks in the area mapped by us in 1918 are rather monotonous in character and consist mainly of greenstones. We have divided the formations into two divisions, the older of which is the Keewatin series, and the younger a series consisting of intrusive rocks which cut the Keewatin.

The Keewatin is made up of basic lavas, mainly basalts or andesites, together with a few acid lavas which we have called rhyolites. We were fortunate in discovering in the township of Holloway, about 10 miles south of Upper Lake Abitibi, an area of Keewatin rocks which was so little altered that we were able to work out a series of lava flows some 4,400 feet in thickness and composed of at least 14 flows, varying in thickness from a minimum of 27 feet to hundreds of feet.

Closely associated with the Keewatin, although not occurring in great volume,

is a sedimentary series composed of chert, slate, greywacké, quartzite, conglomerate, tuff, agglomerate and iron formation. We are satisfied that the iron-formation, tuff and agglomerate belong structurally down in the Keewatin. We are, however, in doubt regarding the stratigraphic position of the other members of this sedimentary series in Beatty and Munro townships, namely, the chert, slate, greywacké, quartzite and conglomerate, although we believe that these rocks are, on the whole, closely related to the Keewatin. At the same time we recognize that some of the conglomerates and other rocks may belong to the Timiskaming series.

The intrusive rocks, which cut the Keewatin and constitute our second division, include granite, syenite, pegmatite, quartz-porphyry, feldspar-porphyry, serpentine, peridotite, pyroxenite, diabase and gabbro. Little is known about the age relationships of these various intrusions, one to another, since we rarely found them in contact with each other. For instance, we do not know the age relationship between the large granite area north of Upper Lake Abitibi and the great intrusion of diabase which comprises Ghost mountain, south of Upper Lake Abitibi. In a general way, however, our work seemed to show that the first intrusions following the Keewatin lava flows consisted of diabase, gabbro, serpentine, peridotite and pyroxenite. These intrusives are probably of pre-Algoman age, and in this respec resemble the lamprophyre and diabase intrusions at Cobalt that are older than the Algoman (Lorrain) granite, and the lamprophyre at Kirkland lake that is older than the feldspar-porphyry and syenite. These basic rocks were then followed by great intrusions of granite, together with dikes of quartz-porphyry, feldspar-porphyry and pegmatite. Finally, all of the rocks were cut by dikes of fresh diabase which resemble the Keweenawan quartz-and olivine-diabase at Cobalt and elsewhere.

The rocks and unconsolidated materials of the area may be conveniently subdivided according to the following table:

TABLE OF ROCKS IN GOLD AREA BETWEEN LAKES ABITIBI AND NIGHT HAWK.

	PLEISTOCENE.
RECENT AND GLACIAL	Sand and gravel, peat. Stratified clay, boulder clay, etc.
	PRE-CAMBRIAN.
INTRUSIVE ROCKS	Quartz-diabase and olivine-diabase dikes (Keweenawan?). Granite, feldspar-porphyry, quartz-porphyry, pegmatite (Algoman?). Serpentine, peridotite and pyroxenite (pre-Algoman?). Diabase and gabbro (pre-Algoman?).
	Intrusive Contact.
KEEWATIN	Chert, slate, greywacké, quartzite, conglomerate, iron-formation.[1] Basalt, diabase, dacite, andesite, rhyolite, pillow lava,[2] hornblende, chlorite and carbonate schists. (Included with these rocks are some agglomerate, tuff, slate, and iron-formation bands which were too narrow to differentiate in mapping.)

[1] Some of these sediments may belong to the Timiskaming series.

[2] The stratigraphic position of the basalt and rhyolite lava flows in Holloway township is not certainly known. Until their age is definitely proved we prefer to place them in the Keewatin series.

Keewatin

The Keewatin series in Ontario has hitherto defied attempts to unravel its structure. The rocks were generally so badly altered and changed to schists that it was found impossible to apply stratigraphic methods to them. The series appeared to be a chaotic tangle of igneous rocks—a hopeless complex devoid of any regular sequence. It was of course believed that the rocks were of volcanic origin and were therefore lava flows, since in many localities in northeastern Ontario volcanic characteristics, such as amygdaloidal textures and pillow structures, were frequently met with. The rocks, however, were so metamorphosed that no workers had succeeded in solving the problem of their structure.

This was our understanding of the Keewatin series when we began our work in the area in the spring of 1918. During the first half of the field season we travelled across mile after mile of amygdaloids, pillow lavas, basalts and other volcanic rocks, and it appeared for a time that we would not be able to make head or tail out of the complex. Finally, however, we began more detailed work about 10 miles south of Upper Lake Abitibi, in the southwest part of Holloway

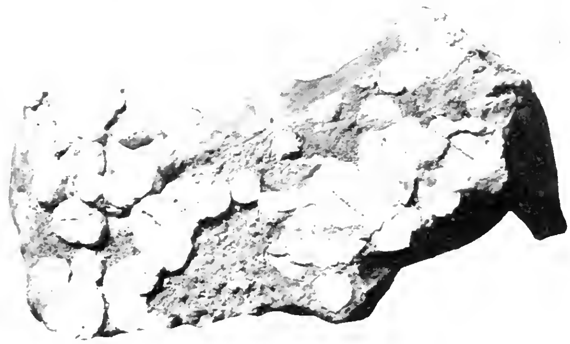


Fig. 7—Weathered surface of spherulitic lava, one-half mile southwest of Howey-Cochenour-Willans gold prospect. Four-fifths natural size.

township in the vicinity of one of the gold discoveries known as the Howey-Cochenour-Willans prospect. Here the rocks were in an unusual state of preservation, and we discovered that the Keewatin consisted of an orderly succession of lava flows which could be mapped. The finding of these flows is of unusual interest. It serves as a key to the unravelling of the Keewatin series, and, we hope, may lead to a better understanding of these rocks. We have described the flows in Holloway township in some detail in following paragraphs.

It is probable that these vast outpourings of lava have come to the surface through great fissures in the crust of the earth, since no volcanoes have been discovered anywhere in northeastern Ontario.

The Keewatin rocks extend easterly into the Province of Quebec, where they have been called the Abitibi volcanics by M. E. Wilson. Regarding the structure and thickness of these Abitibi volcanics Wilson states: [1]

The volcanic rocks of the Abitibi group possess few features from which their structural position can be worked out, but where the lava flows are steeply

[1] Memoir 39, Geol. Sur. Can., p. 58.

inclined their trend can be recognized by their change in texture when crossed in a direction at right angles to their strike. Thus, on the portage from Lake Defresnoy to Sills lake, a hill occurs in which two flows, having an approximate thickness of 600 and 700 feet respectively, and striking N. 55° west, can be recognized. In some places the amygdaloidal structure, flow structure, or ellipsoidal structure is limited to narrow zones, and thus furnishes a clue as to the trend of the rocks. The flattening of the ellipsoids of the pillow lavas on their underside due to gravity can also—as has already been explained—be used to ascertain not only the attitude but the upper and lower sides of the flows. The structural attitude of the volcanics where they are associated with slate and phyllites can, at these points, be ascertained from the strike and dip of the sediments. From the application of the above criteria it was found that throughout a large part of the region—if not throughout its entire extent—the rocks of the Abitibi group have been highly folded and have a strike varying from northwest-southeast to southwest-northeast.

In the third Report on the Porcupine Gold Area the following remarks have been made regarding lava flows in the Keewatin.[1]

Where the pillow lavas are exposed they usually occur in a general northeast and southwest direction, and roughly interbanded with them are other lavas which do not show the pillow structure. The lava with the non-pillow structure is usually of coarser grain than the other, and has a gritty texture on the surface. Frequently there is a well-marked line between these structures, and at other places the pillow structure seems to grade into the non-pillow structure. There is, however, a suggestion of a series of volcanic flows in the Porcupine area which largely make up the Keewatin. Some of the rocks which show the large "eyes" of quartz in hand specimens may represent rocks which are more acid than the basalts. Such a rock as this can be seen on the Krist claim about 800 feet south of the Porcupine Crown south boundary. The rock is greatly altered, but some of the feldspars can be distinguished as belonging to the more acid plagioclase. The rock may be a dacitic type of the flows.

Keewatin Lava Flows in Holloway Township

In the southwest part of Holloway township, about 10 miles south of the shore of Upper Lake Abitibi, there is a remarkable series of lava flows, presumably of Keewatin age. The flows have been tilted up into almost vertical positions, and now dip at an angle of about 80 degrees to the south. Their upturned edges strike approximately east and west—a few degrees south of west astronomic. The time at our disposal was not sufficient to work out the length of the flows, but it was found that one of them extends for at least five miles in an east and west direction. The older flows occur at the north; in other words, younger flows are successively met with towards the south.

The lava flows indicate the great volcanic activity which existed in this part of the earth's crust in ancient times. Even our hurried work showed the presence of 14 distinct flows having a combined thickness of about 4,400 feet. In this thickness of 4,400 feet there may be more than 14 flows, but owing to lack of time, and to the soil which covers the rocks in many places, we did not recognize more than 14. Unquestionably the total thickness of the lava flows must be enormous, since similar volcanic rocks extend for 10 miles to the north as far as the shores of Upper Lake Abitibi, and are reported by prospectors to occur for miles to the south.

[1] The Porcupine Gold Area, Third Report, Ont. Bur. Mines, Vol. 24, Part III, p. 7.

The Keewatin series in the Lake Superior region is considered by Van Hise and Leith to constitute the greatest outpouring of lava on the crust of the earth. The discovery of the flows in Holloway township would tend to confirm this belief.

The volcanic rocks in Holloway township are indisputably stamped with the characteristics distinctive of lava flows. The most striking of these characteristics is the ropy, slaggy and at times half glassy nature of the surface of most of the flows. Fig. 8. Sometimes the surface presents a fragmental appearance. This seems to be due to the fact that the upper part of the flows was the first to solidify into a more or less thin crust, and that this solidified crust then broke up, and allowed the liquid rock from below to well up and cement the broken fragments. No doubt this process may have been repeated over and over again. Other characteristics, which we found for the most part abundantly developed, are the amygdaloidal,

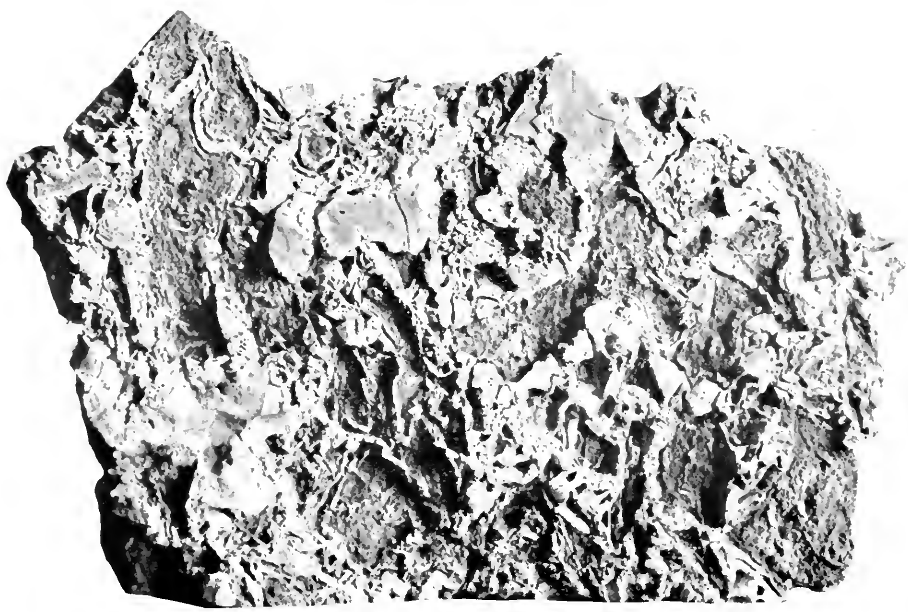


Fig. 8—Ropy surface of basalt lava flow, Lightning river area, Holloway township, at Howey-Cochenour-Willans gold prospect. Four-fifths natural size.

vesicular, scoriaceous, spherulitic, and flow textures. Of common occurrence also are the pillow structures, which are developed in the basalts, but not in the rhyolites.

In order to prove beyond question that we were dealing with a series of lava flows and not a number of parallel dikes, we made a special search for the actual surfaces of the flows. In nearly all of the fourteen flows we found these surfaces. The bottoms were also generally found. It was seen that the dense, fine-grained bottoms were chilled and frozen against the ropy and slaggy surfaces of older flows. If further proof were needed, to show that we were dealing with lava flows, it is found in the study of each individual flow. For instance, the lower parts of the basaltic flows are generally dense, fine-grained, sometimes amygdaloidal rocks; as the centres of the flows are approached the rock becomes

coarser in grain, even as coarse as a medium-grained diabase. This coarse texture, as is well known, is due to the fact that the lava cooled more slowly in the centre. As the surface is approached the flow becomes finer in grain, amygdules begin to make their appearance, and finally the rock assumes the ropy, slaggy and scoriaceous features which are characteristic of the surface of many lava flows.

The thickness of the ropy surface varies in the different lavas; in the flow in front of the office of the Howey-Cochenour-Willans gold prospect the ropy surface makes up almost half the flow, the total thickness of the flow itself being about 27 feet. In other instances these ropy surfaces attain a thickness of as much as 40 feet, in which cases the flows themselves are hundreds of feet thick. Sometimes the ropy surface is only a few feet thick.

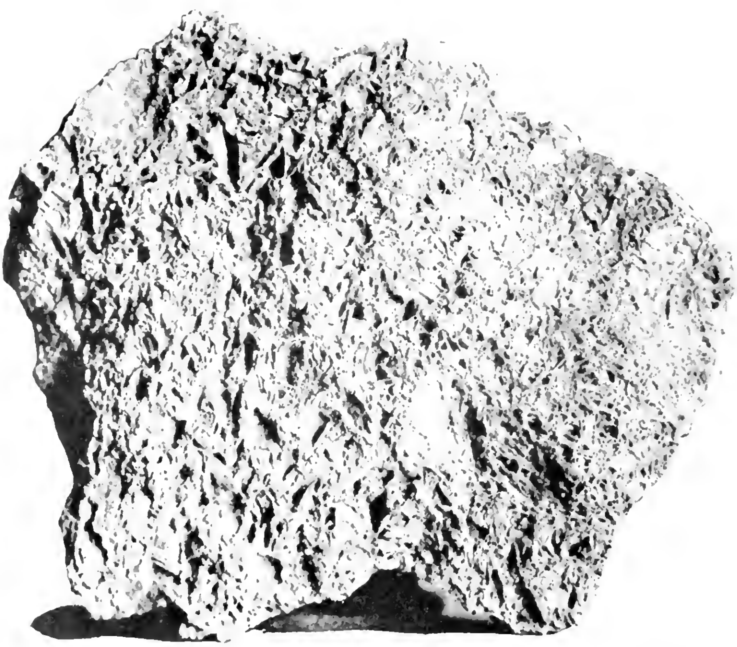


Fig. 9—Surface of basalt lava flow, Lightning river area, Holloway township, at Howey-Cochenour-Willans gold prospect. Five-sixths natural size.

The volcanic rocks briefly described above are in an unusual state of preservation in so far as their textures and structures are concerned. The ropy, slaggy, scoriaceous, amygdaloidal and other characteristics are all easily recognizable. This is due to the fact that the rocks, although they have been tilted into almost vertical positions, have not been subjected to those severe processes of metamorphism which alter them to schists. They, as a consequence, retain their massive characters.

We made a rough attempt to map these flows in Holloway township, but the time at our disposal was too limited to do much. Moreover, none of the mining claims were surveyed. However, we publish with this report, facing page 14, a sketch map which shows the flows, mainly along one section line. Whether the flows really belong to the Keewatin, or are a younger series of rocks, cannot be

dogmatically stated. Until it is proved that they do belong to a younger series, we prefer, in the meantime, to class the flows as Keewatin.

Holloway Lava Flows in Detail

Our examination of the flows was confined largely to a section north and south along the trail which runs northward from the Abnageezy river, past the Howey-Cochenour-Willans gold prospect, in the southwest part of Holloway township. The following description along this section begins with the younger flows at the south and successively deals with older and older flows towards the north.

We have divided the flows into two classes, first, a basic, green variety which we call basalt, and, second, an acid, pink variety which we call rhyolite. It is likely, however, that other types of rock will be recognized among these ancient flows when they are examined in more detail. Probably andesites, dacites, quartz-

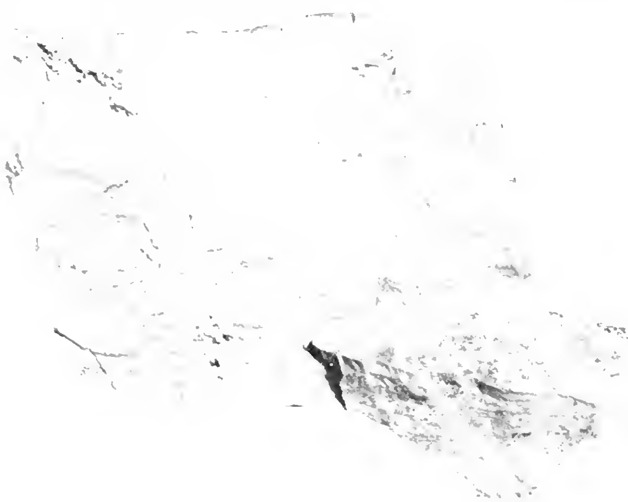


Fig. 10—Flow texture in rhyolite at Howey-Cochenour-Willans gold prospect, Lightning river area, Holloway township. Three-quarters natural size.

porphyries and other rocks all occur. For practical purposes the subdivision into basalt and rhyolite is sufficient.

The first lava at the south end of our section is a basalt. We did not see the top or bottom of this flow, and its thickness was not ascertained. The next flow to the north is a pink rhyolite, about 250 feet wide; it is at times amygdaloidal, and shows under the microscope a holocrystalline texture, consisting of grains of quartz and feldspar, some of the latter being banded. The next flow to the north has a thickness of 650 feet, and the next has a thickness of 1,400 feet; the latter near the base has a well preserved pillow structure. Both flows are basalts. It seems unlikely that these two last mentioned flows are as thick as our cross-section shows: that is to say, detailed work might demonstrate that more than two flows occur in this distance.

The next flow to the north is also a basalt. It is just south of the office of the Howey-Cochenour-Willans prospect, and has a thickness of 27 feet, about 12

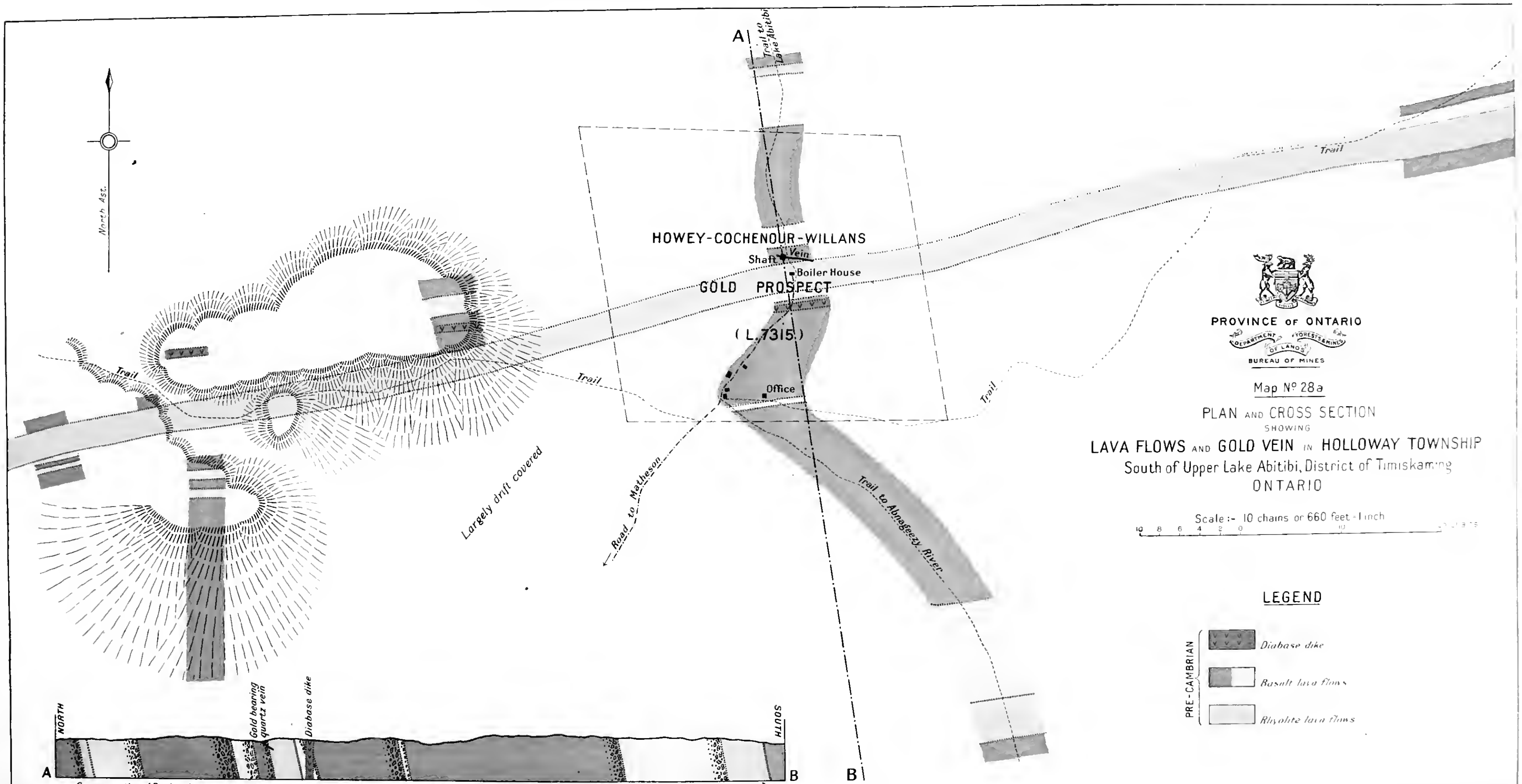
feet of which is made up of ropy, slaggy top. The contact between the ropy surface of this flow and the bottom of the flow immediately to the south is well exposed. The next flow to the north has an apparent thickness of 560 feet; it may include more than one flow, there being some swamp at the north side of the flow. The ropy surface of this flow has a bluish grey colour and retains in places very much the appearance of slag. A dike of diabase porphyry cuts the bottom of the flow, as shown on the map and cross-section facing this page.

The next flow to the north has a thickness of some 60 feet, and consists of basalt. It is followed by a very striking light-coloured rhyolite, which has a pale pink or mauve colour. It has a width of about 200 feet and has been traced in an east and west direction for about 5 miles. It may be longer than this. Amygdaloidal facies are abundantly developed in it, and well defined flow lines (Fig. 10) are not uncommon. Under the microscope no glass was observed in a thin section; the rock appeared to be holocrystalline and to consist mainly of quartz and feldspar grains. Possibly the flow solidified in part as a glass and was later on devitrified. The rock contains tiny cracks in which specular iron ore is commonly found.

A chemical analysis of the rhyolite was made by W. K. McNeill and T. E. Rothwell, Provincial Assay Office, with the following results:

	Per cent.
Silica	80.12
Alumina	9.34
Ferric oxide	2.77
Ferrous oxide	1.00
Lime	0.73
Magnesia	0.23
Soda	4.82
Potash	Trace
Carbon dioxide	0.60
Water	0.18
	99.79

The next flow to the north is a basalt about 95 feet thick. It is in this flow that the Howey-Cochenour-Willans gold vein outcrops on the surface, although the east end of the vein passes into the rhyolite. The central part of this basalt flow is one of the freshest Keewatin lavas which the staff of the Bureau of Mines has examined. It consists mainly of plagioclase and augite showing ophitic textures, Fig. 11. The usual decomposition products, such as chlorite, are present; nevertheless the plagioclase shows more or less clear banding, and the augite is fairly fresh. The actual contact facies at the bottom of the flow—that part which is frozen against the slaggy top of the next flow to the north—is dense and fine grained. The lower 25 feet are also dense and fine grained and contain a few amygdules. Generally speaking, this flow, where it is exposed in the vicinity of the gold vein, lacks the ropy, slaggy surface although the top is quite amygdaloidal. About 200 feet east of the shaft the flow has pillow structure characteristically developed. These pillows begin almost at the very bottom of the flow—two feet from the bottom, to be exact. They continue to within two or three feet of the top in this particular cross-section of the flow.



Cross section AB, showing interbedding of lava flows. The older flows occur at north end of section: hence younger flows occur towards the south

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The next flow to the north is about 115 feet wide and is a basalt. It has a ropy, fragmental looking surface from 20 to 35 feet thick, in which are developed, here and there, curious incipient pillow structures. The top is essentially fragmental in character, being made up of angular, stony, almost glassy fragments of lava from fractions of an inch to as much as four or five inches. The flow, in those parts of it which were examined, lacks typical pillow structures, save the incipient forms just alluded to. The centre of the flow is a massive, medium-grained rock with an ophitic texture. Under the microscope this central part is seen to be unusually fresh, and to contain, in addition to plagioclase and augite, some primary quartz. At a point about 10 feet from the bottom of the flow amygdules are thickly developed, and are associated with some greenish grey fragmental material which has small incipient pillow structures. Possibly this

Fig. 11—Interior of basic lava flow at Howey-Cochenour-Willans gold prospect, Holloway township. Magnified about 20 diameters. One nicol. The long rods are plagioclase, the remaining parts being mostly augite and magnetite.

fragmental looking facies marks the presence of another flow, but we were doubtful as to its interpretation. Thin sections of the slaggy top of the flow show, even with high powers of the microscope, a very fine grained base in which are set tiny rods of what may be feldspar. Another section of the slaggy top lacks these rods and consists of a fine grained base, showing perlitic texture, Fig. 12, in which it is difficult to distinguish the individual minerals.

This flow is followed to the north by another lava of basaltic composition, having a thickness of some 620 feet. The ropy top has a thickness of 40 feet in some places. Thin sections from the central parts of the flow show the rock to be medium to fine in grain and to have ophitic textures.

Immediately north of this is another basaltic flow 330 feet thick.

This is followed by a flow about 55 feet thick which on weathered surfaces has in places a pink colour, and elsewhere a grey or brown colour. Freshly fractured faces have a dark green to grey colour. Phenocrysts of quartz and feldspar are common and are large enough to be recognized with the naked eye. The rock is quite amygdaloidal and shows flow textures. It appears to vary somewhat in composition from point to point, and may change from a dacite to a rhyolite. This flow occupies a slight depression.

To the north of this lava there is a basaltic flow of great, although unknown, thickness in which pillow structures are well developed.

Beyond this to the north for 10 miles, as far north as Upper Lake Abitibi, similar lavas are found, but we made no attempt to work out individual flows, except on the shores of Upper Lake Abitibi, where we recognized the ropy surface of a thick flow, on which rests directly a pillow lava. These two flows are described in the following paragraphs.

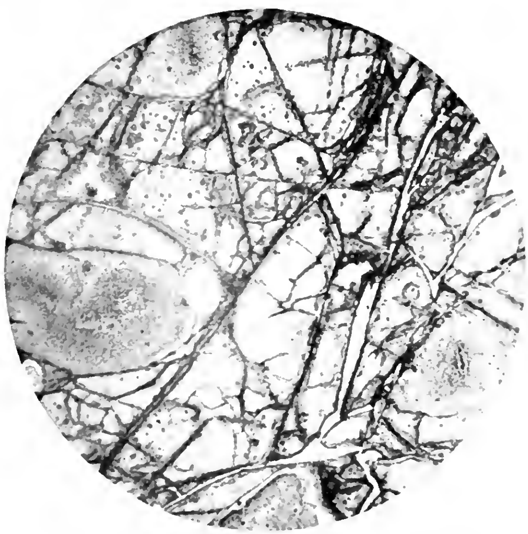

Fig. 12—Perlitic texture in surface of basalt lava flow, Howey-Cochenour-Willans gold prospect, Lightning river area, Holloway township. Magnified about 20 diameters. One nicol.

Keewatin Lava Flows on Upper Lake Abitibi

On the south shore of Upper Lake Abitibi, at the northwest corner of Stoughton township, there are exposed two green coloured, basaltic, pillow lava flows on a point known as No. 103a. This point is shown, with the number, on the map accompanying our report. The thickness of the flows was not worked out, since we saw only the upper part of one flow and the lower part of the other, Fig. 13. The contact between the flows is, however, exposed and appears to strike in a northeasterly direction, while the dip is about 50° to the northwest. The older lava occurs at the southeast. The lower part of the older lava, where exposed, shows pillow structure. As the upper part is approached the rock, somewhat abruptly, assumes the ropy, slaggy appearance characteristic of the surface of lavas. The transition between that part of the flow containing pillow structures, on the one

hand, and between the ropy facies, on the other hand, takes place in about 18 inches. The thickness of the ropy surface is great—about 200 feet or more. Much of the ropy top has a fragmental appearance, Fig. 11, some of the fragments of which are amygdaloidal. None of the ropy, fragmental looking top shows bedding. It is difficult to say, however, whether or not there is any true volcanic ejectaments (tuff or breccia) mixed in with the ropy surface.

Resting directly on this ropy surface is the younger pillow lava. The pillows in the younger flow are developed to the very bottom of the lava. Higher up in this younger flow the pillows disappear, and the rock becomes coarser in grain. The top of the flow was not observed.

At the contact between the flows the rock is schistose for three or four inches, the schistosity possibly being due to a slight fault between the flows.

In the case of these two flows the younger lava is at the northwest, while the older one is at the southeast. Ten miles south of here, however, in Holloway township, the order is reversed, and the younger lavas occur at the south. This structure is suggestive of an anticlinal fold, one arm of which lies towards the north and the other towards the south.

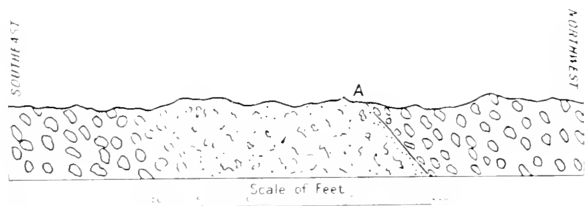

Fig. 13—Pillow lava flow at right hand side of drawing, resting on the ropy surface of an older pillow lava flow; the contact between the two flows is shown at the point A. South shore of Upper Lake Abitibi, at the northwest corner of Stoughton township.

Lava Flows in other parts of the World

It may not be out of place here to add a few paragraphs briefly describing important outpourings of lava in other parts of the world, ranging in age from pre-Cambrian to historic times.

The flows of the Keweenawan series, of pre-Cambrian age, in the lake Superior region vary from about two feet to those which are 100 feet or more in thickness. In only two instances do they reach a thickness of 500 feet. The thin flows are not of great length, nor, for the most part, are the thicker flows. The greatest distance which a single flow has been followed is 30 miles. In some parts these Keweenawan flows in the lake Superior region have a total thickness of 23,000 feet.[1]

While the flows on Keweenaw Point are of stupendous thickness they are rivalled, nevertheless, in areal extent by the great outpouring of lavas in India known as the Deccan Trap. The Deccan Trap consists of many flows and covers a region of 200,000 square miles; in the vicinity of Bombay the flows have a total thickness of 6,000 feet. The lavas in India are younger than the Keweenawan flows, the former belonging to the Cretaceous period.

In the northwestern United States there is a remarkably similar, though younger, series of basaltic lava flows having about the same stupendous areal extent

[1] U. S. G. S. Monograph 52, 1911, pp. 386, 408, 409.

as the Deccan Trap in India. These flows are known as the Columbia lava and cover a region of between 200,000 and 250,000 square miles. When one reflects that this is a greater region than France and Great Britain combined, some appreciation of the gigantic nature of these volcanic outbursts may be realized. The Columbia lava is widespread throughout Idaho, Oregon, Washington and Northern California. It is composed of many sheets, some of which are separated by sediments of Tertiary age, and has a maximum thickness of 4,000 feet. One of the flows, varying in thickness from 10 to 100 feet, has been traced for 75 to 100 miles. In parts of this immense expanse of lavas the surface is covered with rich soil, the result of the decomposition of the basalt. The wheat lands of Oregon and Washington are nourished in this kindly earth and, in the words of Russell: "In the autumn the boundless plateau is a golden sea of waving grain."[1]

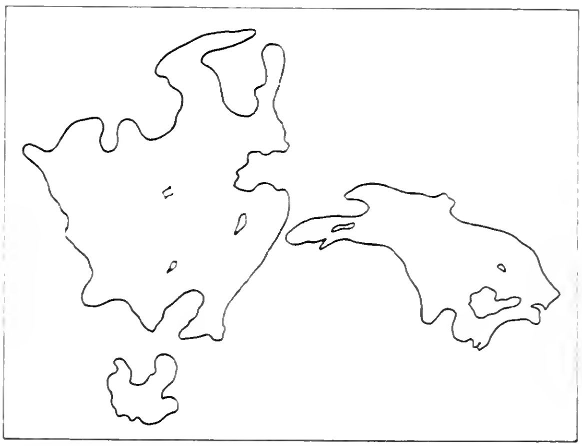

Fig. 14—Ropy fragments in surface of pillow lava flow on the south shore of Upper Lake Abitibi, at the northwest corner of Stoughton township. The largest fragment in drawing is eight inches long.

There are also great lava flows of Tertiary age in the northeast part of Ireland, of which the well known Giant's Causeway constitutes a part. The bed that forms the Giant's Causeway is about 70 feet thick. The flows in Ireland are thought by Geikie to be a remnant of vast outpourings which at one time covered a stretch of country from the Orkney Islands southwards into Yorkshire and across Britain from sea to sea over a region of not less than 10,000 square miles.[2]

The volcanic eruptions on Keweenaw Point of the Lake Superior region, the Columbia lava in the northwestern part of the United States, the Deccan Trap in India, and the flows in Ireland, all occurred in prehistoric times. Coming now to historic times, it is well known that the greatest outpouring of lava on record occurred in 1783 in Iceland. This eruption issued from a fissure 20 miles long "and poured forth in two vast floods, of which the western branch flowed for upwards of 40 miles and the other 28 miles."[3]

[1] Volcanoes of North America, I. C. Russell.
[2] Text Book of Geology, Geikie, Vol. I, p. 346.
[3] Text Book of Geology, Geikie, Vol. I, p. 342.

It is believed by geologists that all of the lava flows referred to above have issued from great fissures in the earth's crust, rather than from volcanoes. Indeed, it is now generally accepted as the truth that fissure eruptions played a more important part in the history of lava flows than did volcanoes. The absence of volcanic necks in the regions referred to supplies a basis for this theory.

Keewatin Rocks in Marriott, Harker, Frecheville and Lamplugh Townships

A volcanic rock along the southwest shore of McDiarmid lake in Marriott township is light green in colour. It is amygdaloidal, and contains considerable carbonate. The greenish colour is due to chlorite that occurs in distinct small

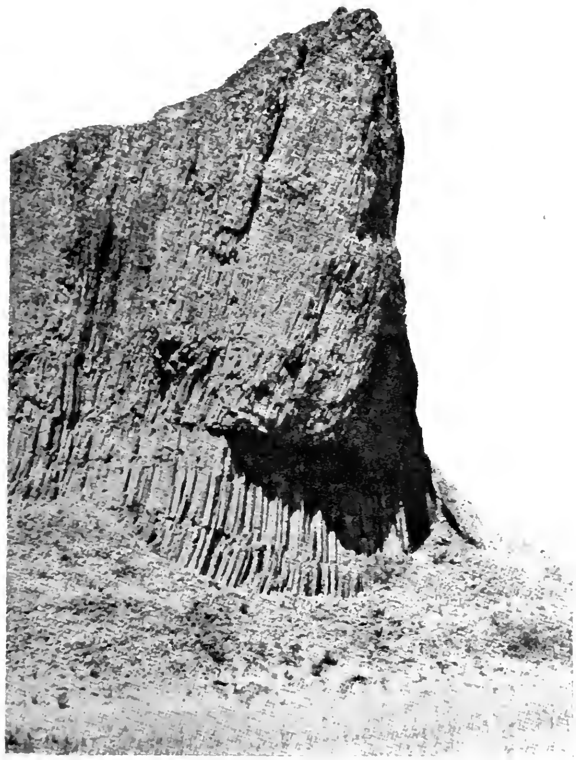

Fig. 15—Columbia lava, showing columnar jointing, in the State of Washington, U.S.A.

rounded areas as an alteration from a ferro-magnesian mineral. Two feldspars are recognized, the larger lath-like crystals that are probably andesite and the smaller rod-like crystals of a more acid plagioclase; the rock may be a bleached andesite.

In the northeast part of Harker township to the south of the Ghost range there is a rock light to dark grey in colour and somewhat schistose that in the field resembles an agglomerate. On examination, however, it proves to be an igneous rock through which are scattered fragments of porphyry. The main rock is of a porphyritic character also, consequently it would seem that the frag-

ments have resulted from an early crystallization from the same magma. The phenocrysts of the main mass and of the fragments are acidic plagioclase. A flow structure is recognized in the small feldspars of the groundmass of some of the fragments; the rock may be called a porphyrite.

In Frecheville township, to the northeast of the Ghost range, just below the forks of the Lightning river, there is a light-coloured schist. As the diabasic rock of the Ghost range is quite massive, it is evident that these schists on either side are considerably older than the diabase and are probably of Keewatin age.

In Lamplugh township, a sample of fine-grained greenstone from a high ridge on the south shore of Upper Abitibi lake, one mile west of Lightning river, which is typical of most of the fine-grained basic lava along the lake, has a basaltic texture under the microscope. Fine rods of plagioclase having a flow structure are set in a matrix of secondary minerals, largely green fibrous hornblende and zoisite. This rock frequently shows an ellipsoidal structure in the field.

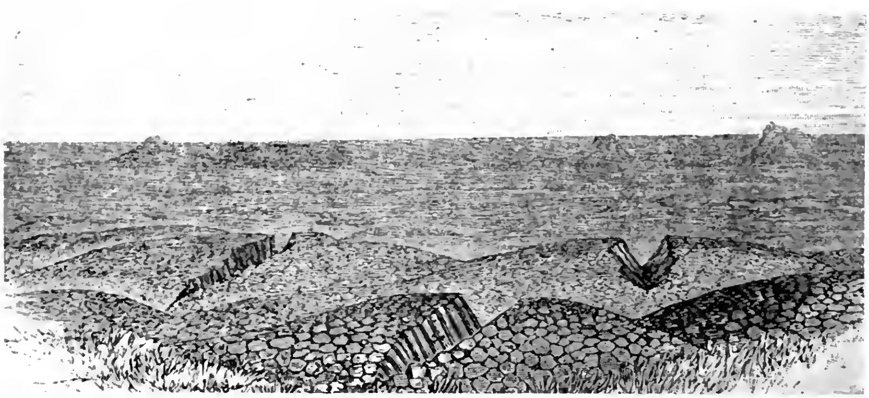

Fig. 16—View of the great basalt plain of the Snake river, Idaho, U.S.A. (Geikie's Text-Book of Geology, second edition.)

Keewatin Rocks in Beatty, Calvert, Knox, Wilkie and Clergue Townships

The rocks in the western half of the area which were mapped in 1918 consist dominantly of volcanic rocks, including ellipsoidal basalt, light-coloured rhyolite, andesite, diabase and dacite (?), many of which have been completely altered to hornblende, chlorite, carbonate and other schists. The extrusives are separated at intervals by bands of iron-formation, volcanic fragmental material and water-sorted sediments. All the above rocks are intruded at times by diabasic rocks of the plutonic type which are probably post-Keewatin in age. A more detailed description of certain types follows.

The extrusives probably represent successive flows which have been tilted into almost vertical positions. These rocks are usually so much altered that it has not been possible to recognize the original tops and bottoms of the flows, or to map them as has been done in Holloway township. Many of the basalt and andesite flows have the usual ellipsoidal and amygdaloidal structures, while some of the intervening flows may be described as massive, coarse-grained, altered diabase and dacite (?) which have no pillow structure. A typical ellipsoidal basalt

from the north half of lot 2 in the second concession of Beatty township was analyzed by W. K. McNeill, Provincial Assayer, who reported the following:—

	Per cent.
Silica	51.80
Alumina	17.25
Ferrous oxide	9.66
Ferric oxide	3.11
Lime	4.01
Magnesia	2.68
Soda	3.88
Potash	0.58
Carbon dioxide	3.08
Water	4.16
Total	100.21

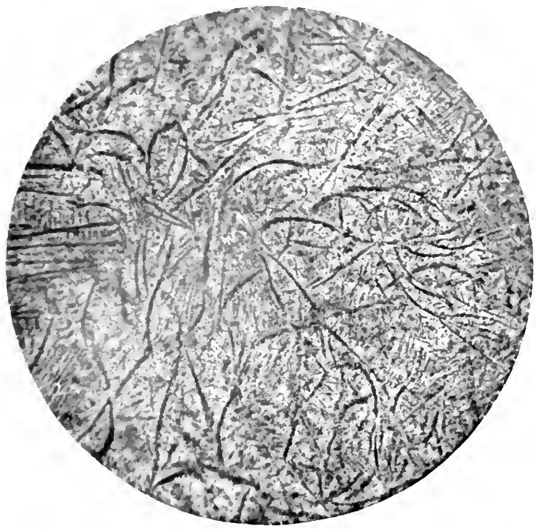

Fig. 17—Crystallites in spherulitic lava. One mile post, west boundary, Marriott township. Magnified about 40 diameters. One nicol.

A thin section of the same rock showed a number of small rods of anorthite partly replaced by sericite and a few small grains of quartz in a groundmass of hornblende, largely decomposed to chlorite, with some calcite, sericite, kaolin, epidote, pyrite and magnetite. In many of the thin sections examined all of the minerals, including the feldspars, are secondary.

Small veins of prehnite a few inches in width occur in the pillow lava near the diabase in the northwest corner of lot 9 in the fifth concession of Calvert township. A sample analyzed by W. K. McNeill gave the following results:—

	Per cent.
Silica	40.36
Alumina	26.02
Ferric oxide	3.41
Ferrous oxide	0.39
Lime	23.08
Magnesia	0.14
Soda	0.99
Potash	None
Carbon dioxide	0.79
Water	4.52
Total	99.70

In the southwest part of Knox township alternating flows of pillow lava and massive, fairly fresh greenstone with ophitic texture may be seen.

At the Alexo mine both andesitic and rhyolitic types are found, one passing into the other. A light grey rhyolitic rock showing quartz phenocrysts and a few amygdules appears to be interbanded with pillow lava and chert and cut by quartz-diabase on lot 4 in the first concession of Wilkie township. Under the microscope the diabase is seen to consist largely of quartz with some feldspar, chlorite, calcite and sericite. The carbonate schist in which the Quinn gold-bearing quartz vein occurs was apparently a rhyolite flow originally. The microscope shows the rock to contain many phenocrysts of quartz and intergrowths of quartz and feldspar set in carbonate with chlorite, iron oxide, etc. A porphyry or rhyolite mass, 10 feet in width and showing crushed or flow markings, occurs associated with the dacite (?) at Twin falls. Somewhat similar rhyolite may be seen on lot 2 in the fourth concession of Clergue township.

Keewatin Schists

The rocks in the area covered by the map are on the whole massive, and are not altered to schist. There are, however, some notable exceptions. For instance, on Lightning Point the Keewatin lavas are altered to schist, this alteration quite evidently being due to the great intrusion of granite which is exposed on the north shore of Lake Abitibi. Schistose structures are found in some of the rocks in the westerly part of the Indian Reserve near the boundary line of McCool township. On lot 3 in the fifth concession of Calvert township, and on lot 9 in the sixth concession of the same township, the pillow lavas have been metamorphosed to hornblende schist, probably due to their proximity to granite. The rocks on the Raty claim in central Rickard township are a little schistose and impregnated with carbonate. Along the Shallow river, on lots 10 and 11 in the second concession of Wilkie township, there are quartz-porphyries of Keewatin, or later age, which are rusty and quite schistose. Green schists form the periphery of a porphyry mass over one-quarter of a mile in width in lot 12 in the second concession of Warden township.

The rhyolite containing the Quinn gold-bearing quartz vein has been altered to a carbonate schist. Hornblende schist is most prevalent in south Bowman township. It is cut by tongues of granite which are probably offshoots from a large granite mass to the south. An andalusite schist, showing crystals of chiastolite set in a groundmass of radiating sillimanite and other minerals, was recognized on lot 5 in the fifth concession of Beatty township. M. B. Baker refers to a quartz-mica-staurolite schist striking nearly east and west on the Low Bush river in lot 7, concession V, Bowyer township.

The tuffs, slate and greywacké are usually schistose.

Chert, Slate, Greywacké, Quartzite, Conglomerate, Tuff, Agglomerate and Iron Formation

In our map sheet there is an interesting series comprised of highly altered sediments which are closely associated with the Keewatin. Three large areas of such rocks have been mapped. One belt has an apparent thickness of one and one-half miles and a length of 11 miles, extending from the northwest part of Guibord

township to lot 2 in the sixth concession of Carr township. Other belts not so extensive, extend across lots 5, 6 and 7, in the second concession of Coulson township, and along the shore of Abitibi lake in Steele township. Some smaller areas have also been mapped.

The rocks in the three large areas mentioned in the preceding paragraph consist of slate, greywacké, quartzite and a little conglomerate, all of which have been altered to schists. Both the cleavage and bedding of the sediments have nearly vertical dips, but there are usually small angles between their strikes. A little

Fig. 18—Bomb-like inclusion in tuff, lot 8, concession 1, Mann township.

chert is also present. Conglomerate schist was seen in four localities and, in each case, near the outer edge of the sediments, viz.: on the Detroit New Ontario property, Munro township; on lot 1 in the second concession of Beatty township, on lots 6 and 7, second concession, Coulson township, and on the shore of Lower Abitibi lake in lot 6, concession E, Steele township. The pebbles, which are somewhat flattened, consist of quartz-porphyry and greenstones, suggesting an unconformity between the sediments, on the one hand, and the greenstones and quartz-porphyry, on the other. However, the only good contacts which were seen between the sediments and the greenstones were on lot 7 in the second concession of Coulson township, and these might suggest that the sediments were interbedded with the pillow lavas of the Keewatin. It may be added that in

this locality the banded cherts, which appear to be a part of the main group of sediments, are older than pillow lavas. In view of these apparently conflicting observations, it is seen that the relationship between the Keewatin lavas and these old sedimentary rocks has not been definitely worked out. Possibly the conglomerates may be of interformational origin or may belong to the Timiskaming series.

A porphyry dike, three feet wide, cuts across the greywacké schist on the Detroit New Ontario property. Many diabase dikes intrude the sedimentary series in various localities, as shown on the map.

Some gold has been produced at the Gold Pyramid and Detroit New Ontario properties which occur in these sedimentary rocks.

Other areas of these sediments, and also of iron formation, are described in following paragraphs.

Fig. 19—Point at mouth of Ghost river, Upper Lake Abitibi.

A white weathering, tufaceous, rusty schist occurs on the Abitibi river on lots 7 and 8 of the fifth concession of Rickard township. The schist strikes 10° south of east and dips 70° to the north: it is intruded by a narrow dike of quartz-diabase. At Little Couchiching falls, in Knox township, is a group of interbedded rocks, now schists, comprising pillow lava, ash rocks, cherty iron-formation and a rusty schist with coarse white quartz grains, the last being a tuff or quartz-porphyry schist. Narrow bands of cherty iron-formation were observed with the pillow lava on the Baty claim, Rickard township. On lot 1 in the fifth concession of Teefy a shallow pit has been sunk on a banded chert striking northeast and southwest and dipping 70° to the northwest. The chert associated with the rhyolite and pillow lava on lot 4 in the first concession of Wilkie township consists almost entirely of fine-grained quartz. A tufaceous schist from lot 1A in the second concession of Coulson township consists microscopically of angular fragments of

feldspar, quartz and foreign rock fragments in a groundmass of feldspar, quartz, calcite, chlorite, etc. Certain veins from these rocks have yielded low values in gold. A narrow band of slates, standing vertically and striking northeast, occurs with amygdaloidal lava on lot 5 in the fourth concession of Warden township.

M. B. Baker[1] refers to jasper-magnetite bands occurring with dolomite on island No. 14 and on the mainland immediately north of that on Lower Abitibi lake. Much iron-formation also occurs on the east shore of the northeast bay of Lower Abitibi lake.

Along the south shore of Upper Abitibi lake, from the Ghost river to the Mattawasagi (Teddy Bear) river, there are numerous exposures of basic igneous rock, largely pillow lavas and related diabasic rock, that are cut by numerous narrow dikes of feldspar porphyry. From the Ghost river to the Lightning river there are a number of narrow bands of iron-formation that are interbanded with the lavas. Just east of Point 144 A. is a band of finely banded fragmental material, four feet in width, and another band two feet wide of chert-like iron-formation. At Point 143 A. the iron-formation is 100 feet in width, consisting of interbanded greywacké-like layers of coarse and fine material, chert-like bands four to six inches wide, and black bands of magnetite and silica a few inches wide. The whole formation dips steeply to the north between bands of greenstone. The northerly band of greenstone is cut by a 20-foot dike of feldspar-porphyry. Just west of Point 142 A. the iron-formation is 50 feet wide, largely of grey chert and greywacké, but it contains one striking layer a foot in width, of bright red jaspilyte containing jasper and hematite. East of Point 137 A. there is a band of similar material 100 feet in width. There is considerable variation in the strike of these bands of iron-formation, from nearly east and west to nearly north and south. Since the rock exposures in this locality are confined to the shore, with stratified clay above the rock exposures inland, it is impossible to say whether all these exposures belong to separate bands, or whether some of them may be outcrops of the same band. Rocks resembling volcanic ash and having an east-west strike occur along the shore on the east side of Lightning point.

In the southeast part of McCool township and the southwest part of the Indian Reserve altered volcanic and related rocks are well exposed. Many of these rocks are now partly schistose with a general strike of N. 60° W. and show bleached or rusty weathered surfaces. Both the ellipsoidal and amygdaloidal structures are observed in the volcanics. These are accompanied by breccia, agglomerate, rocks largely altered to carbonate, cherts and diabase. An interesting rock occurs about 60 chains east of the one-mile post between McCool and the Indian Reserve. It is hard, light-greenish, silicious rock containing pea-like inclusions that resemble amygdules, Fig. 20. Under the microscope the rock is largely fine-grained silica scattered through which are grains of ferruginous carbonate, some in rhombic forms and also rounded patches of the same material. There is also a small amount of secondary mica present. On weathering the inclusions of carbonate become altered to iron oxide, beginning with a thin film on the periphery. The scattered grains are also altered on the surface to iron oxide. This rock is a member of the Keewatin iron-formation.

[1] Ont. Bur. of Mines Report, 1909, Vol. 18, Pt. I, p. 276.

The following is a chemical analysis of the chert: Silica, 72.78 per cent., alumina, 7.61, ferrous oxide, 4.91, ferric oxide, 1.04, lime, 4.20, magnesia, 0.72, soda, 1.00, potash, trace, carbon dioxide, 6.98, water, 1.13 per cent.

To the south of the chert there is a rock greatly altered to carbonate which shows traces of a former igneous texture.

Twenty chains south of the one-mile post there is a hard flint-like rock of a dark grey colour which bleaches to a light grey on the surface. Under the microscope it is very fine-grained, but irregular grains of quartz and feldspar are recognizable, suggesting a fragmental origin. This rock may be a very fine-grained tuff. It is intruded by numerous diabase dikes in a complex manner. To the south there is a vertical contact with a conglomeratic rock with the strike N. 60° W.

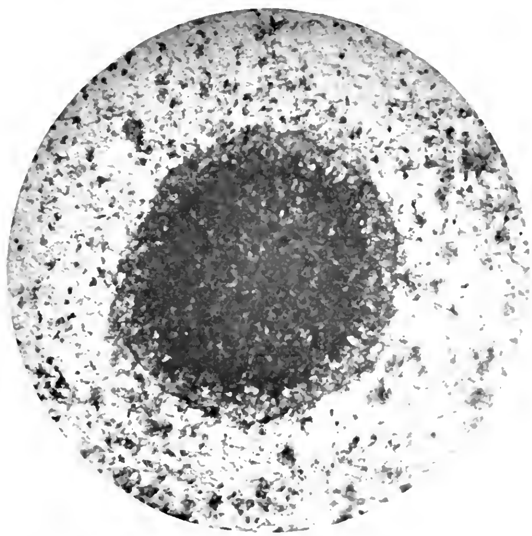

Fig. 20—Concretionary ferruginous carbonate (dark area) in chert, 60 chains east of one mile post, east boundary of McCool township. Magnified about 20 diameters. One nicol.

The latter contains many inclusions of other rocks, among them amygdaloidal lava and rusty weathering fragments; also some fragments very like the fine-grained hard rock previously mentioned. There is a little banded arrangement of coarse and fine material near the contact where the fragments are usually four to six inches in diameter. One inclusion of amygdaloidal lava is, however, eight feet in diameter. Farther away the inclusions are small, being only one to two inches. It is likely this material is volcanic fragmental, and is part of the series of lavas and other rocks just described.

The series is intruded by several narrow dikes of feldspar-porphyry with phenocrysts up to one-half an inch.

In Boundary bay on Upper Lake Abitibi there are beds, Fig. 21, which appear to be agglomerate and tuff, having an exposed thickness of about 60 feet. Some of the beds contain considerable quantities of ankerite. A brief description, beginning with the highest exposed member, is given below:—

	Thickness in feet.
(1) Agglomerate, containing fragments up to one foot in diameter, passing downward into finer tufaceous material	30
(2) Well bedded slaty material (tuff?)	4
(3) Greenish-coloured bed, lacking bedding and intersected by veinlets of ankerite one inch wide	13
(4) Rusty brown tuff (?), impregnated with ankerite and also intersected by ankerite veinlets	22
(5) Iron formation consisting of 1 to 4 inches of red jasper and grey chert....	0-4 inches
(6) Similar to bed No. 4	5
	74 ft. 4 in.

The measurements given are taken along the surface. Inasmuch, however, as the beds dip at an angle of 60 degrees to the northeast, the actual thickness of the series, allowing for the dip, is about 60 feet. The agglomerate bed, No. 1, contains fragments of chert and jasper, and of fine-grained felsitic material.

The relation of these tuffs and breccias to pillow lavas, which are exposed nearby, was not seen.

A prominent band of iron formation occurs at the northeast part of Garrison township over a mile south of the north boundary. Other outcrops of iron formation,

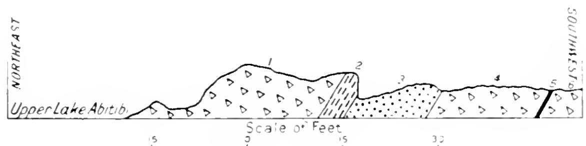

Fig. 21—Beds of agglomerate and tuff associated with Keewatin pillow lavas, in Boundary Bay, Upper Lake Abitibi.

tion, already mentioned, occur on the south shore of Upper Lake Abitibi and elsewhere. These deposits of low-grade iron ore, which occur abundantly throughout the pre-Cambrian rocks of northern Ontario, constitute immense reserves, but at the present time the iron smelters will not use ore of this character because it is too low in grade and cannot compete with the rich and easily mined deposits in the Lake Superior region.

It has been shown in certain areas in the Vermilion district of the Lake Superior region that some of the Keewatin iron-formation (Soudan formation) beds are interbedded with successive basalt flows. These beds of iron-formation are but a few feet thick and may be traced hundreds of yards. The tops of the flows are recognized by amygdaloidal and other surface textures.[1]

Intrusive Rocks

Cutting the Keewatin there are various basic and acid rocks the ages of which have not all been determined. These include diabase, gabbro, serpentine, pyroxenite and peridotite, probably of pre-Algoman (?) age; granite, syenite and acid porphyries of Algoman (?) age; and quartz-and olivine-diabase of Keweenawan (?) age.

[1] U. S. G. S. Monograph 52, Van Hise and Leith, pp. 123, 126.

Diabase and Gabbro

The diabase and gabbro, the oldest of these intrusives, occur as dikes and small boss-like masses. Ghost mountain is an example of a large dike or sill of this type. The rocks have a slightly older look in the field than the Keweenawan or Nipissing diabase at Cobalt, and microscopic examinations tend to confirm the field evidence. A sample from a point on the west shore of Upper Abitibi lake and one and one-half miles south of the Narrows shows the feldspar altered to kaolin and sericite and the augite to hornblende and chlorite, there being many graphic intergrowths of quartz and altered feldspars. In some of the larger outcrops the rocks may become quite coarse at times and still retain the ophitic texture, while in other places the diabase may grade into gabbro. Considerable

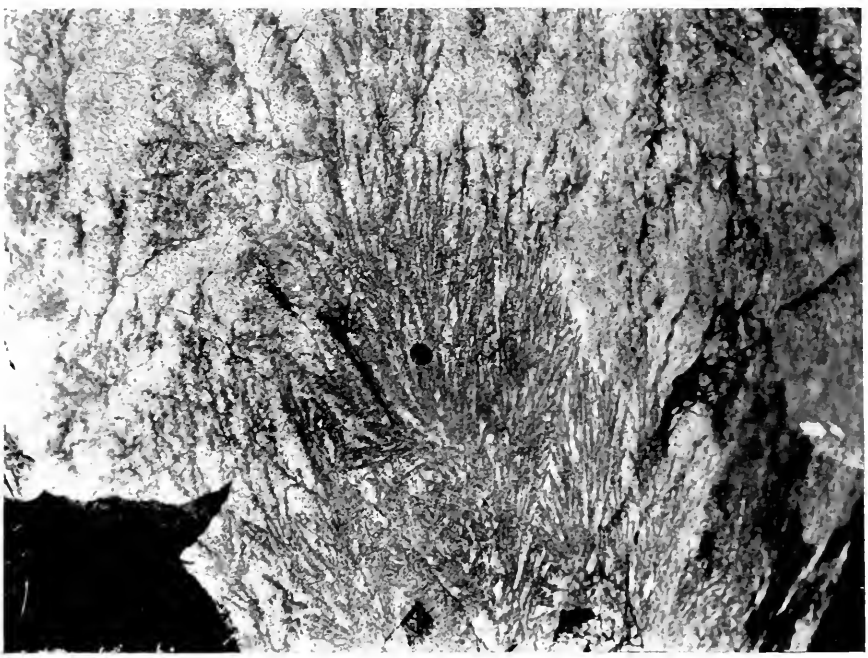

Fig. 22—Dendritic epidote in diabase, McCool township.

magnetite is usually present in the rock, an outcrop on lot 12 in the first concession of Warden township containing approximately 25 per cent. of magnetic iron.

The boss-like mass of diabase in north Munro and south Warden townships is probably the largest outcrop in the map-sheet, having an area of approximately 8 square miles. Throughout the mass are small roof pendants, or erosion remnants, of chert, iron-formation and greenstone. In addition, the diabase contains numerous rounded and angular fragments of the same rocks, viz.: chert, iron-formation, greenstone, etc., which were sinking in the magma when the diabase magma solidified. Good examples of these xenoliths, as they are called, may be seen along the north edge of the boss, particularly along the shallow river in lot 1A, in the first concession of Coulson township and in the north part of lot eleven in the first concession of Warden township.

The massive gabbro in lot 2, concession II, Bowman township, appears to be of this pre-Algoman type and younger than the Keewatin. This particular gabbro is intruded by quartz-feldspar-porphyry.

Several large areas of diabase are exposed in McCool township and in one or two small areas in Michaud. In the field these are characterized by a somewhat browner surface than the Keewatin diabase, and they lack pillow structure. In general they are coarser in grain, being rather granitoid. A striking feature that is somewhat common is a dendritic development of epidote, Fig. 22, which is possibly to be looked upon as an indication of slower cooling than is the case with most diabase. Microscopically, it appears to be a normal diabase with part of the augite altered to hornblende. There is a small quantity of quartz present as a micrographic intergrowth with the feldspar, suggesting conditions similar to those necessary for the formation of pegmatite. Aside from the presence of serpentine dikes which cut this formation, no evidence of economic minerals was observed.

Fig. 23—Serpentine rock, at base of Ghost mountain, south side. Magnified about 20 diameters. Cross nicols.

Diabase and Serpentine of Ghost Mountain

Ghost mountain is the most prominent elevation in the area south of Upper Lake Abitibi. It rises about 660 feet above the lake, and stretches in an eastward and westward direction for five miles, with a width of about a mile. The mountain consists almost wholly of diabase or gabbro which is presumably intrusive into the Keewatin lavas. It is more altered than the Nipissing diabase at Cobalt. The rock is made up essentially of plagioclase and pyroxene, both of which are more or less altered to the usual decomposition products. Small quantities of primary quartz occur.

While the mountain consists almost wholly of diabase, or its closely related rock, gabbro, we found that there is also serpentine rock, together with pyroxenite

and peridotite, Figs. 23, 24. The position of the serpentine rock is of interest. It occurs around the base of the mountain at the north, west, and south sides, in an apparently continuous band or zone on these three sides. Unfortunately, there is much drift around the mountain, so that we were not able to prove that the serpentine completely encircles the whole base of the mountain, including the east end.

Such exposures, as we found, appear to suggest that the diabase passes downward into serpentine rock. This has not, however, been proved to our satisfaction. The occurrence at Ghost mountain, in which the serpentine is found at the bottom of the diabase mass, suggests that the olivine and pyroxene, from which the serpentine has been derived by alteration, have segregated to the bottom of the mass, if the intrusion is a sill. If the intrusion is a great dike-like mass or boss, then the olivine and pyroxene may have segregated to the outer edges. It was

Fig. 24—Serpentine rock, at base of Ghost mountain, south side. Magnified about 20 diameters. Cross nicols.

found unpracticable to work out the structure of Ghost mountain, that is to say, whether it is a great dike-like intrusion, or the remnant of a sill which at one time, prior to its erosion, was much more extensive. To accomplish this it would, of course, be necessary to find contacts between the Keewatin lava flows and the diabase or the serpentine rock. Owing to the presence of heavy drift surrounding the base of the mountain no such contacts were discovered.

If the diabase is in the form of a sill then the occurrence of olivine at the base is suggestive of geological conditions at the Insizwa range in South Africa, in which a sill of norite passes downward into basic rocks, carrying more or less olivine.

A number of narrow prehnite veins an inch wide were seen in the diabase; the mineral analcite was observed with the prehnite in one of these veins.

On the north side of the mountain in the burnt part, and not far from the

bottom, there is a cave about 50 feet long which extends into the mountain 30 feet. It is 4 to 8 feet high and occurs in the diabase or gabbro which constitutes most of the rock on the mountain. The rock at the cave is much slicken-sided and is cut by numerous small quartz stringers. The floor is covered with blocks of rock fallen from the roof, so that its actual height could not be ascertained.

Serpentine, Peridotite and Pyroxenite

Serpentine rock occurs in many localities in the area which we mapped in the summer of 1918. Its importance as an "ore bringer" has been demonstrated at the Alexo nickel mine in the townships of Dundonald and Clergue where a deposit of nickel occurs at the contact of a mass of serpentine and andesite. It has been shown at the Alexo mine that the ore, which consists of pyrrhotite, pentlandite and chalcopyrite, is associated with the serpentine and owes its origin to this rock.

The importance of serpentine rocks is further shown in Reaume township[1] where chromite occurs in small quantities. The chromite in this township contains diamonds of microscopic size and, in addition, small quantities of platinum. None of these minerals—platinum, diamonds or chromite—occurs in economic quantities, but we believe, nevertheless, that all serpentine rocks should be carefully prospected in northern Ontario for these minerals, and also for asbestos and nickel.

The serpentine rocks, in the area covered by the writers, result from the alteration of olivine and pyroxene, although some of the pyroxene in many instances still remains unaltered. The most important mass of serpentine in the area mapped in 1918 is that at the Alexo nickel mine in Dundonald and Clergue townships, and is referred to under the heading of Nickel on page 63.

Another occurrence was found on Lightning mountain at the south end of Frecheville township. This serpentine area is described on page 66.

These very basic rocks are generally found in low-lying areas, in the neighbourhood of which the compass is no guide. Their frequent association with the diabase which has just been described suggests some genetic relationship between the two rocks. Serpentine can be seen grading into diabase across a width of some 20 feet in lot 10, concession I, Warden. Also, the serpentine appears to encircle the base of the Ghost diabase range which suggests a differentiation product at the base. Apart from these two cases, however, the serpentine appears to cut the diabase as in lot 12, concession I, Warden. Further, some of the pillow lavas in Munro township appear to be altered to serpentine, therefore the serpentine may be of different ages. Most of the rock, however, appears to be younger than the pre-Algoman (?) diabase and older than the (Algoman?) granite and porphyry. Narrow porphyry dikes can be observed intruding the serpentine in lot 7, concession VI, Beatty township. The Keewenawan diabase cuts the serpentine in the same locality and in lot 7, concession I, Coulson township.

The fresher specimens show some crystals or crystal outlines of olivine but usually they have been altered to serpentine and contain much dolomite and

[1] Ont. Bur. Mines, Vol. 23, Part I, 1914, pp. 47-48.

magnetite. A sample of this serpentine from a point on the line between lots 6 and 7 in the first concession of Coulson township and 385 yards north of the town line gave the following on analysis by W. K. McNeill:—

	Per cent.
Silica	39.08
Ferric oxide and alumina	7.84
Ferrous oxide	17.84
Lime	3.02
Magnesia	19.02
Carbon dioxide	2.79
Water	9.05
Alkalies (estimated approximately)	2.00
	100.64

Frequently, the serpentine contains a network of black magnetite veinlets which withstand the weathering and project above the white-weathering serpentine. Specimens of such material from lot 10 in the first concession of Warden township

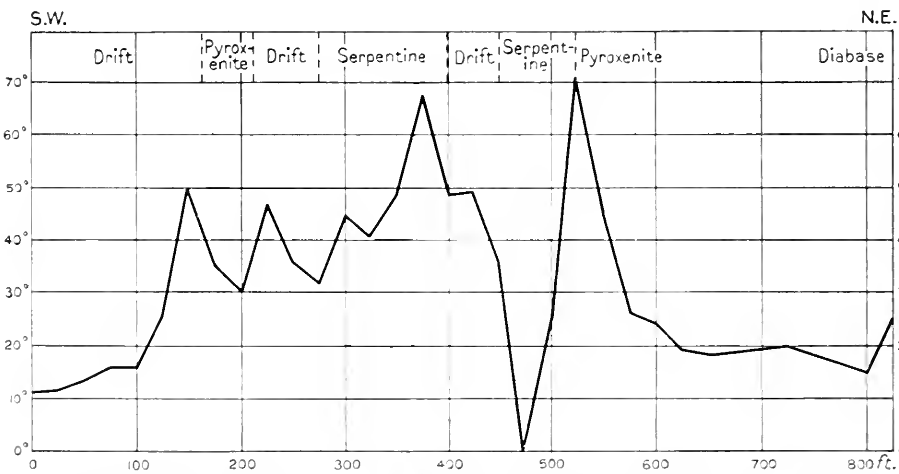

Fig. 25—Dips found in crossing serpentine, lot 8, in the second concession of McCool township.

were analyzed and found to contain no chromium or platinum. In other parts, the crevices are filled with narrow asbestos veinlets which are described under asbestos.

In the township of McCool exposures of serpentine and pyroxenite extend in a northwesterly direction from lot 8 in the second concession to lot 12 in the fourth concession. On the surface the serpentine along this belt appears nearly white with scattered specks and stringers of magnetite, giving a slightly mottled appearance. Originally the rock was a peridotite and the outline of the original olivine crystals is well preserved. The magnetite shows well developed crystals and is of the variety known as lodestone. The compass is of no use when crossing one of these deposits, as the magnetic variation is in some cases more than 65°. Dip-needle readings would suggest the desirability of carefully prospecting, possibly with a diamond drill. Figure 25 gives the dips found in crossing the exposure in lot 8 in the second concession of McCool township, the readings being taken at

intervals of 50 feet. The zero reading in the midst of the serpentine was rather surprising, though readily explained as the neutral zone in a magnetic field. The contact between the pyroxenite and the serpentine is quite sharp, as is the case in the peridotite deposits near Webster, N.C., where nodules of the orthorhombic pyroxene enstatite are found embedded in the peridotite, having solidified from the molten magma before the olivine. On the other hand, the contact between the pyroxenite and the diabase is not sharp, there being apparently a gradation from one to the other. The dip-needle readings, however, appear to indicate a break which was not observed in examining the rock. The outcrop of lot 10 in the fourth concession of McCool township shows not only veinlets of magnetite, but some schist with asbestos fibres about an inch in length. Further prospecting might reveal this valuable material in economic quantity.

Granites

In the south central part of Garrison township there is a boss of medium-grained reddish hornblende granite. This rock intrudes the greenstone, and is probably of Algoman age. It is everywhere quite massive, and in places sends dikes into the older basic rocks. Several contacts between the granite and the older rocks can be seen along the wagon road. In hand specimens it is difficult to recognize the quartz in the granite, but under the microscope the mineral is abundant. The chief constituents are arthoclase, microcline, plagioclase, hornblende and quartz, with scattered crystals of sphene, apatite and magnetite. At one place on the road there is a quartz vein carrying a little pyrite along the contact of granite and greenstone, but an assay of material from it showed no gold. Near the summit of the hill to the north of the road there is a flat or sill-like intrusion of grey mica granite in the greenstone, probably an offshoot from the main granite mass a short distance to the north.

M. B. Baker states that hornblende granite, which in places becomes a hornblende syenite, forms the whole of the north shore of Upper Abitibi lake and parts of South bay and the east shore of Lower Abitibi lake. Gold-bearing quartz veins occur in this granite at Point 48 A, South bay, and traces of gold can be obtained from a pegmatite dike on lot 4, concession C, Steele township, suggesting a genetic relationship between the granite and the gold veins.

Some massive hornblende biotite granite cut by diabase occurs along the Okikodasik river.

Massive, medium-grained, pink hornblende-granite occurs along the Abitibi river on lots 2, 3 and 4 in the fifth concession of Calvert township. Narrow pegmatite dikes, offshoots from the granite, intrude the Keewatin rocks in this vicinity.

The only gneiss observed in the area is the hornblende granite gneiss near mileage XCVII on the interprovincial boundary, and on the Canadian National railway in the west part of Sargeant township.

A coarse crushed grey hornblende granite, containing round orbicular masses or spherulites, occurs on lot 2 in the fourth concession of Carr township, and on lot 4 in the first concession of Wilkie township. The round white masses are

usually half an inch in diameter with a radiating structure frequently coming from a hollow centre.

All the granites are intruded by narrow dikes of Keweenawan (?) diabase.

The only granitic rocks found in the township of Michaud are in lot 8 in the third concession, and in lots 9 and 10 in the third and fourth concessions. This rock varies from a normal granite to a granite porphyry, and, so far as observed, shows no signs of mineralization. It is referred tentatively to the Algoman series, though there is no contact visible which will definitely settle the age.

Quartz-Syenite

There are two small bosses of massive red quartz syenite in Harker township. The rock is quite coarse-grained, consisting almost wholly of red feldspar crystals up to one-half an inch in length. Fresh pieces of the rock are very striking, and suggest value as an ornamental stone. These bosses of syenite were not observed in contact with other rock, but are likely of the same relative age as the granite previously mentioned.

With the exception of outcrops of granite on Abitibi lake, these few outcrops of acid plutonic rocks were the only ones observed to the south of Abitibi lake.

Fig. 26—Photomicrograph of feldspar-porphyry showing altered albite phenocryst in fine-grained groundmass, lot 8, in the fourth concession of Rickard township. Magnified about 20 diameters. Cross nicols.

Pegmatites, Feldspar, Quartz and Granite-Porphyry

These acid intrusions, some of which are offshoots from granite, intrude all the other rocks of the area except the Keweenawan (?) diabase. They occur as narrow grey and flesh-coloured dikes varying from 50 to 2 feet in width with the exception of two larger masses in concession III of Beatty township and in lot 12, concession II, Warden township. In the latter locality the pinkish porphyry is over one-quarter of a mile in width, and contains numerous large phenocrysts of feldspar and rounded quartz.

A granite-porphyry or rhyolite over one-quarter of a mile wide and frequently showing the spherulitic structure extends for 3 miles across concession III of Beatty township. The same rock extends eastward into the centre of Munro township, where it has not been separated from the Keewatin complex. A sample of the rock from lot 10, concession II, Munro, gave on analysis by W. K. McNeill, the following:—

	Per cent.
Silica	78.70
Alumina	6.56
Ferrous oxide	0.90
Ferric oxide	2.51
Lime	2.11
Magnesia	0.28
Soda	1.58
Potash	6.42
Carbon dioxide	0.42
Water	0.65
	100.13

The porphyry dikes on the Raty claim on which a small gold ore shoot was found consist of rounded phenocrysts of albite, feldspars showing zonal structure, quartz and hornblende in a microcrystalline groundmass of hornblende, chlorite, plagioclase, feldspar, quartz and apatite.

A quartz porphyry now altered to schist occurs on the Shallow river in lot 11, concession II, Wilkie township. There are a number of narrow porphyry dikes up to 20 feet wide and generally pink in colour, which intrude the greenstones and some of the diabase, along the south shore of Upper Abitibi lake. These dikes usually show distinct phenocrysts of feldspar, and sometimes quartz, in a fine grained groundmass. One dike from station 143 A. contains phenocrysts of albite, in a mixture of feldspar, quartz and secondary mica.

At point 100 A. on the south shore of Upper Abitibi lake a dike of feldspar-porphyry intrudes pillow lava and is itself cut by a dike of granite two inches in width.

On island 661 S.V., near the mouth of the Lightning river, a feldspar-porphyry dike is intruded by a trap dike two inches wide.

A pegmatitic dike intrudes iron-formation on the northeast shore of Lower Abitibi lake in lot 1, concession D, Steele township.

M. B. Baker mentions numerous beautiful granite porphyries and pegmatite dikes cutting the Keewatin greenstones near the granite rocks on the Abitibi lakes. Other pegmatites occur in the vicinity of Iroquois Falls and in south Bowman township.

The porphyries are in many places cut by the Keweenawan (?) diabase as shown on the map.

Keweenawan?

Certain dikes of quartz-diabase penetrate all the other rocks of the area and are classed as Keweenawan. The dikes usually dip vertically, and the majority of them strike nearly north and south. They vary from a few inches to 200 feet in width and are often traceable for miles. A typical sample from lot 6, concession I, Beatty township, was examined microscopically and found to consist of

labradorite laths partly altered to saussurite and sericite, augite partly decomposed to hornblende, and chlorite with a little quartz, biotite, apatite and magnetite. Intergrowths of quartz and feldspar are common.

Occasionally there are porphyritic varieties which have large white-weathering phenocrysts of greenish feldspar up to 2 and 3 inches in thickness. One of this type may be seen on the north boundary of Hislop township, in lot 9, a sample from which yielded, on analysis, 50.7 per cent. of silica. Another example may be seen on the Raty claim, Rickard township.

Accompanying the diabase in the vicinity of Painkiller lake are some small porphyry masses which are regarded as acid differentiation phases of the diabase magma. However, most of the porphyries in that area are not of the differentiation type.

Fig. 27—Keweenawan (?) diabase dike, northwest of Mt. Smollett, Lamplugh township. Magnified 50 diameters. One nicol.

A dike of diabase, about 100 feet wide, occurs to the northeast of Mount Smollet, where it strikes northeast and southwest. It is very fresh under the microscope, containing both labradorite and andesite in lathlike structure, Fig. 27, together with augite and a little quartz. This rock is probably one of the latest rocks in this area, and a member of the Keweenawan. Only a few dikes as fresh as this were noted. A similar one occurs in a high ridge on the west side of Lightning river, two miles from its mouth.

A fresh olivine diabase is found on the east shore at the north end of the narrows between Upper and Lower Abitibi lakes. Similar dikes may be seen on lot 2 in the fourth concession of Carr township, on lot 1 in the second concession, Taylor township, and on the Okikodosik river immediately above the Canadian National railway.

Pleistocene

About 90 per cent. of the area is drift-covered, two-thirds of the unconsolidated material being suitable for agricultural purposes, the remainder consisting largely of sand and peat. These deposits are often quite thick, the hills at Nellie lake being about 200 feet high, and some well holes put down at Matheson showing over 100 feet of drift. The deposits consist of boulder clay, stratified clay, sand, gravel, silt, peat and moss. As a rule the clay deposits occupy the low-lying parts of the area, including that portion of the country most suitable for agriculture. Many areas of clay, sand, gravel and peat have been differentiated on the map.

In an article, "Lake Ojibway: Last of the Great Glacial Lakes," A. P. Coleman[1] refers to the wide extent of a vast glacial lake, formed to the north of the height of land, in Ontario and Quebec, with stratified clay formed in the deeper parts, and sand and gravel deposits along its southerly shore line near the height of land. He advances the theory that the present large lakes, Abitibi, Night Hawk and Frederick House, are remnants of the larger lake Ojibway, left after the retreat of the Labrador ice sheet.

More recently, Jos. Keele[2] has examined the Pleistocene in parts of northern Ontario and suggests the possibility of a number of old glacial lakes, with intervening areas of boulder clay and other glacial deposits, not covered by the water of a glacial lake.

The stoneless clays found at or near the surface in northern Ontario, are nearly all composed of sediments deposited in glacial lakes which were formerly of large dimensions. Lake Abitibi may be taken as an example of the shrunken remnant of a once extensive lake of this character. The distribution of the clays are governed, therefore, by the extent of territory covered by these lakes and the height to which the water encroached on the land surface, and to the subsequent drainage which extinguished or partly extinguished these lakes, and made their sediments available as land surface. Considering the land area of northern Ontario as a whole the areas underlain by stoneless clay sediments are very small and widely scattered.

That the large shallow lakes of the present day are remnants of much larger bodies of water is proven by the wide areas of stratified clay around these lakes. High banks of stratified clay are found along the south shore of Upper Abitibi lake near the mouth of the Mattawasagi river. In the latter locality the banks are at least 30 feet higher than the lake and contain an occasional rafted boulder, dropped from a floating iceberg. Similar stratified deposits can be observed at a few points up the valleys of other rivers along the south shore of Upper Abitibi lake, and for at least 8 miles along the Frederick House river below the lake of the same name. In fact, the clays can be traced almost continuously from Abitibi lake westerly along the Abitibi river and up the Driftwood river to a point not far from Night Hawk lake, suggesting that these two lakes were probably connected at one time.

The lake clays are as thick as 50 feet as shown in the V-shaped valley of

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[1] Eighteenth Report, Bureau of Mines, Ont., 1909.

[2] Summary Report, Mines Branch, Department of Mines, 1917; Investigation of Clay and Shale Resources, p. 102.

Abitibi river and by two drill holes sunk at Matheson by the T. and N. O. Railway Commission. If the top of the boulder clay at Twin falls, elevation 835 feet, be taken as the base of the lake clays, and the stratified clay hill near the mouth of the Mattawasagi river, elevation 905 feet, be taken as the top of the lake clays, there would be at least 70 feet in thickness of these sediments.

Underneath the clays the rocks are usually polished and striated and frequently in the form of *roches moutonnées*. Lying directly on the rock there is generaly stratified clay, but there may be boulder clay as at Twin falls, where a bed at least 10 feet thick and at an elevation of 825 feet, lies on rock and is overlain by a great thickness of stratified clay. A small amount of boulder clay may be seen on the Frederick House river on lot 3 in the third concession of Little township at an elevation of approximately 880 feet. In other places, as in the vicinity of Cochrane, elevation 908 feet, the boulder clay may be seen at the present surface.

Fig. 28—Stratified clay lying on boulder clay. Twin falls, Abitibi river, Teefy township.

The sand and gravel occur as moraines, kames, eskers, outwash plains and lake deposits.

About two miles southwest of the mouth of Ghost river, in the Indian reserve, there is a flat plain-like deposit of sand, evidently an old lake deposit, that probably was formed in the shallow water of the old lake of which Abitibi lake was a part. A similar plain was observed two miles south of the one just referred to.

Characteristic glacial deposits can be observed in various parts of the area south of Abitibi lake. Along the boundary line between Garrison and Michaud townships are several esker ridges. Some of the sloping sand areas seen in Garrison and Harker townships may be outwash plains. A morainic deposit of sand and gravel and boulders can be followed for several miles in a north and south direction in the central part of Holloway township.

A deposit of water-washed sand and gravel was found on the south side

of a high ridge near its summit on the Perron claim, L. 7307, in Harker township. The probable explanation of such a deposit is that it was formed by marginal drainage while the ice-sheet still filled the valley to the south.

Extensive morainic and other glacial deposits from a quarter of a mile to two miles in width can be traced for 36 miles from Bowman township northerly to Hughes station on the Canadian National railway. In places the deposits are covered by lake clays and clay loam, showing that there was much damming in glacial times. Clay overlying morainic deposits may be seen near the junction of the Shallow with the Black river. Trenches up to 20 feet in depth immediately south of the town of Matheson required in the construction of a water supply system, and three deep well-holes at Matheson also show clay lying on sand and gravel.

Fig. 29—Trilobe mountain, McCool township, showing two eskers, the one near the lake being about 30 feet high.

The kame deposit immediately south of Matheson comprises coarse stratified sand and gravel probably deposited by a sub-glacial river as the ice retreated.

The highest drift deposits are the sand and gravel morainic ridges immediately east of Nellie Lake station. These hills rise 250 feet above the surrounding plain, or have a summit elevation of approximately 1,250 feet, and were probably islands in an old glacial lake. On the east side of these hills are terraces which may have been formed at different levels as the lake lowered.

In most of these deposits there are numerous kettle lakes which form the source of clear-water creeks. Many other kettle holes are dry.

J. G. McMillan refers to a large sand area extending northwesterly from Frederick House lake and paralleling the Frederick House river a short distance from it, as shown on the map.

These sandy deposits are unsuitable for farming, but, when convenient, are used for railway ballast, road dressing and construction purposes. Much of the jack, red and white pine covering these deposits is suitable for ties and lumber.

Locally, the townships of Michaud and McCool are spoken of as sand plains. This description, however, gives an erroneous impression as the country is decidedly rolling, though considerable areas are level. Apparently the surface deposits are to be attributed to the accumulation of glacial material which consisted principally of sand. The most striking feature of these deposits is a most elaborate system of sand ridges, Fig. 30, which presumably were originally eskers. In consequence of a fire which burned practically all vegetable material over a large area, leaving the sand without bonding material, these eskers are being remodelled by wind so that some of them have the appearance of dunes, and in the early summer before vegetation had started this area presented the appearance of a desert. In the later summer, however, when most of the area was covered by grasses and other low plants, the landscape was more attractive. The soil except on the ridges is in the nature of a sandy loam in which certain types of wild grasses and huckleberries thrive. It should be an ideal place for growing small fruits, other conditions being favourable.

Fig. 30—Sand ridge, presumably an esker, now being remodelled by winds. Michaud township.

Throughout the townships of Michaud and McCool are numerous kettle lakes, most of which have no apparent inlet. The largest of these, Perry lake, Fig. 4, is more than a mile long and half a mile wide, and has an outlet about 15 feet wide.

Muskegs or Peat Bogs

The muskegs or peat bogs cover approximately three per cent. of the map-area, usually occurring in the poorly drained parts, but not necessarily at low elevations. They vary in size from a few acres to 3,000 acres, and are composed of sphagnum and other mosses up to 15 feet in depth. The surfaces of the bogs are almost treeless, or contain small black spruce trees, an inch or two in diameter, which gradually increase in size as the edge of the bogs is reached. The two largest peat bogs near railway transportation occur at Nellie lake and at Mileage 240 on the Timiskaming and Northern Ontario railway in Newmarket

Fig. 31—View of Frederick House river looking down stream, lot 8, in the first concession of Mann township. The old channel where High falls was located is shown on the left of the illustration. The new channel on the right shows where the river has cut through an embankment fifty feet in height.

township, while many smaller ones occur along the Canadian National railway between Hughes and Low Bush stations. The bogs adjacent to the Timiskaming and Northern Ontario railway were examined by A. Anrep of the Canadian Geological Survey during part of 1918. Mr. Anrep found the largest bog, viz., the Nellie lake bog, to be of good quality and to have a thickness of about 10 feet. Many of the bogs could be drained as they form the source of numerous streams.

Other large peat bogs, more remote from the railway, occur in Rickard, Edwards and Moody townships. Some of the larger bogs situated near the railway, such as the Nellie lake bog, may at some time afford a large supply of fuel if the coal supply should be insufficient.

Fig. 32—Faults in clay, Frederick House river, township of Little, May, 1910.

Frederick House Lake and River

In the autumn of 1909, after the discovery of gold in Porcupine, Father Paradis tried to facilitate prospecting on his claim by lowering the water in the Frederick House river. This was accomplished by making a small cutting in the clay embankment next High Falls, in lot 8, concession I, Mann township. The water at the Falls flowed over a shoulder of compact rock. The clay on the right bank was 50 feet or more in thickness, and the water having been once diverted into the soft clay, soon formed a deep gorge resulting in the disappearance of the 46-foot falls and the destruction of a valuable water power. In May, 1910, W. G. Miller and C. W. Knight spent a few days examining the effects which the lowering of the water had had on the banks and bed of the river. A detailed account of this is given by Mr. Knight.[1] P. E. Hopkins passed down the river in August, 1918, and found that much erosion had taken place since 1910. Water flows quietly around the point where High Falls was situated. The falls have worn back far enough to lower the river level and drain the south half

[1] Can. Min. Journal, Feb., 1911, pp. 91-93.

of Frederick House lake. The cutting down of the stream would have extended back much farther towards Night Hawk lake had not an artificial dam been built across the Frederick House river at Connaught station to prevent further wearing back, and for the purpose of making the upper Frederick House river and Night Hawk lake more navigable.

Naturally the greatest cutting down of the river bed has taken place immediately above High Falls. The deep cutting has extended back for 3 miles to lot 5, concession V, Little township, where a rock barrier has been encountered, forming a 10-foot falls. In the 3-mile gorge the water is swift and there are two 3-foot rapids. The undermined clay banks have tumbled down, and the tree tops have been tossed over to almost meet those from the opposite bank. Above the 10-foot falls the current is sluggish for 2½ miles to a point where the river has cut through sand and gravel underlain by boulder clay, which contains some boulders over 6 feet across. The river above this last rapid is swift and still deepen-

Fig 33—Howey-Cochenour-Willans camp, Holloway township (Lightning river area.)

ing its bed. The south half of Frederick House lake is now a sand and clay flat with the river winding through it. Settlers built houses and attempted to cultivate the old lake bottom, but found the soil unsuitable for crops.

The drift deposits along the Frederick House river are stratified lake clays covered with loam, except the boulder clay on lot 3, concession III, Little township, mentioned above. Half a dozen isolated rock outcrops, viz.: quartzose schist, agglomerate, conglomerate (?), basalt and tuff with large bomb-like inclusions occur along the river between lot 5, concession III, Little township and the old High falls. Between High falls and Three rapids no rocks occur, and the banks are low. At either end of the Three rapids there is serpentine, the intervening rock being gabbro. A greenstone schist occurs on the river near the centre of concession V, Little township, with serpentine to the north and south of it.

Economic Geology

Gold

In many localities in northern Ontario where gold has been discovered there are occurrences of acid intrusives that have suggested a genetic relation between the acid rocks and the gold deposits. These rocks are usually of an acid porphyry or granite type. In the area to the south of Abitibi lake there are occasional narrow feldspar-porphyry dikes. A few of these occur along the shore of the lake near the mouth of the Mattawasagi (Teddy Bear) river, where gold has been found, and these are described elsewhere in this report. In Garrison township there is a boss of hornblende granite, and in Harker two small bosses of hornblende syenite; otherwise, with the exception of the rhyolite flows in the Keewatin, all the igneous rocks of the area are of a basic character. No porphyry dikes have been observed in the vicinity of the Howey-Cochenour-Willans gold discovery, and this is one of the few places where such acid rocks are not found near gold deposits.

In other parts of the area, namely, in Munro and Rickard townships and at Painkiller lake, where gold deposits occur, one will find porphyry masses. The magmatic waters connected with these porphyry intrusions may have had much to do with the gold deposition.

Lightning River (Holloway and Harker Townships)

The chief interest in the area centres in its gold discoveries, and while a few claims have been partly prospected, on the whole only a limited amount of work has been done, due to the lack of prospectors and the distance of the area from a railway.

Most of the work has been done in the southwest part of Holloway and the southeast part of Harker, adjacent townships.

During the geological examination of the area to the south of Abitibi lake a few narrow quartz veins were noted by us in the townships of Garrison, Frecheville and Harker, away from the known area in Holloway and Harker townships, where gold had been discovered by prospectors. Samples of the quartz veins were taken for assay, and values up to 80 cents per ton were obtained. These veins occur on some of the higher ridges, where the rock is readily accessible and probably harder and less likely to contain gold-bearing veins than in lower land, where trenching would be necessary to expose the rocks and any possible veins. There are a few isolated outcrops of schist in Harker and Holloway townships to the south of the Ghost range, and there is probably an area of altered rocks along the valley of the Mattawasagi (Teddy Bear) river, but owing to the large amount of drift it would be difficult to prospect.

Gold was discovered in the Lightning river area in August, 1917, by Messrs. Howey, Cochenour and Willans. At that time it was a difficult matter for prospectors to get into this little known area. During the summer of 1918, however, a rough road was built from near the Croesus mine into the Howey-Cochenour-Willans claims, this road being a continuation of the road which runs from Matheson to the Croesus mine. From Matheson, on the Timiskaming and Northern Ontario railway, to the Howey-Cochenour-Willans prospect, it is more than 40 miles by road. The area may also be entered by going to La Reine, north of Upper

Lake Abitibi on the Canadian National railway. La Reine is 72 miles east of Cochrane, and is in the Province of Quebec immediately east of the interprovincial boundary. A gasoline boat may be taken at La Reine, and Upper Lake Abitibi reached by going down the Okikodosik river a distance of about 5 miles. From the mouth of this river it is about 17½ miles south-west across Upper Lake Abitibi to the mouth of Lightning river. A small gasoline boat may be taken about six miles up Lightning river to a point where the river forks, at which point a portage about six miles long leads south directly to the Howey-Cochenour-Willans prospect. Lumber camps were built in the autumn of 1918 a few miles up the Lightning river, and also a few miles up the Mattawasagi river (Teddy Bear). The establishment of these lumber camps requires frequent trips by the large

Fig. 34—Entrance to inclined shaft, Howey-Cochenour-Willans gold prospect, Lightning river area, Holloway township.

gasoline freight boats from La Reine or Low Bush, in order to keep the camps supplied with food and other material. The members of our party were very kindly treated by officers of the Abitibi Power and Paper Company, and we were shown hospitality not only at their lumber camps but also on their freight boats.

The boundary lines of the eight townships south of Upper Lake Abitibi were surveyed during the summer of 1918 by Provincial Land Surveyor H. J. Beatty, but the lot and concession lines were not run. These newly surveyed townships, namely, Stoughton, Frecheville, Lamplugh, Rand, Garrison, Harker, Holloway and Marriott, were named after men well known in the mining and geological world.[1]

[1] Can. Min. Jour., May 1st, 1918, p. 146

Howey-Cochenour-Willans.—Work on the Howey-Cochenour-Willans claim, No. 7135, has been largely confined to an examination of the vein in which the original discovery of gold was made in August, 1917. This vein has been traced by means of pits and trenches a distance of 175 feet. At the westerly exposure it is in the basalt, and at the easterly exposure in the rhyolite. At the west outcrop in the basalt an inclined shaft has been sunk on the vein where the dip is 23° south. When the property was last visited by us the shaft had reached a depth of 35 feet and the vein was still in the basalt, which rock lies to the north of the rhyolite, the strike of the contact of the two rocks being to the south of west and the dip being about 80° south. From information furnished by J. W. Morrison, who was manager of the property at that time, it has been learned that when the shaft penetrated the contact the low dip of the vein was maintained, and the contact between the rocks had been displaced a distance of four feet on the plane of the vein. This evidence points to the formation of the vein along an inclined fault that intersected the rock formations, Fig. 35.

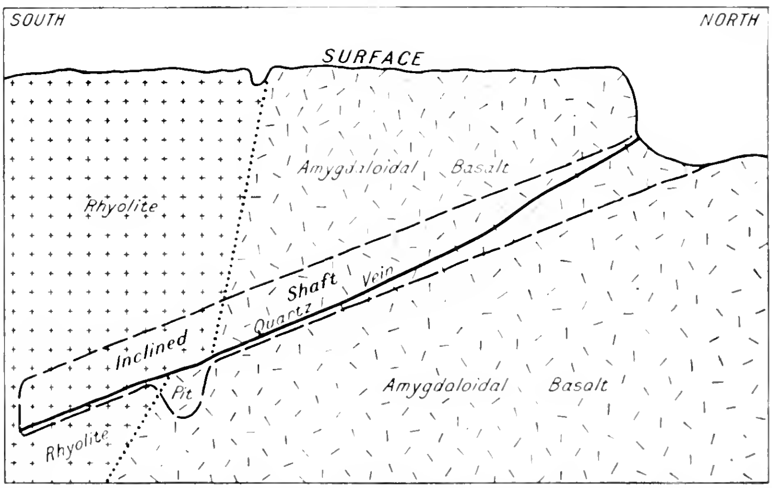

Fig. 35—North and south vertical section, showing basalt and rhyolite contact, and location of quartz along a fault that crosses the two rocks with a throw of 4 feet. Inclination of shaft is 23°. Howey-Cochenour-Willans gold prospect. Scale approximately 20 feet.

The lode structure, as revealed in the shaft to a depth of 35 feet, shows a main persistent quartz vein, varying in width from an inch to 10 or 12 inches, with an average width of about 4 inches. Roughly paralleling this main vein there are a number of narrow quartz veinlets usually less than an inch in width and more or less discontinuous, the whole partaking of the character of a sheeted zone produced by shearing that accompanied the formation of the fault. This zone varies in width from about 2 to 3 feet, Figs. 36, 37.

The quartz for the greater part is of a milk white colour and, where not fractured by secondary movement, is rather coarse-grained and characteristic of primary quartz in veins. Where the primary quartz has been granulated, Fig. 38, usually in a direction roughly parallel with the walls, there is an abundance of secondary calcite with pyrite and a small amount of chlorite. Some pale-coloured

zinc blende and a little galena are also present. The quartz along these crushed zones is in very fine grains, several of which show by their orientation that they are parts of a larger crystal. Fragments of greatly altered country rock are enclosed in the quartz of the vein. Some of these fragments are of different character from the enclosing altered basalt wall rock. Most of the pyrite and other sulphides occur in the crushed areas, but these are sometimes seen in the clear

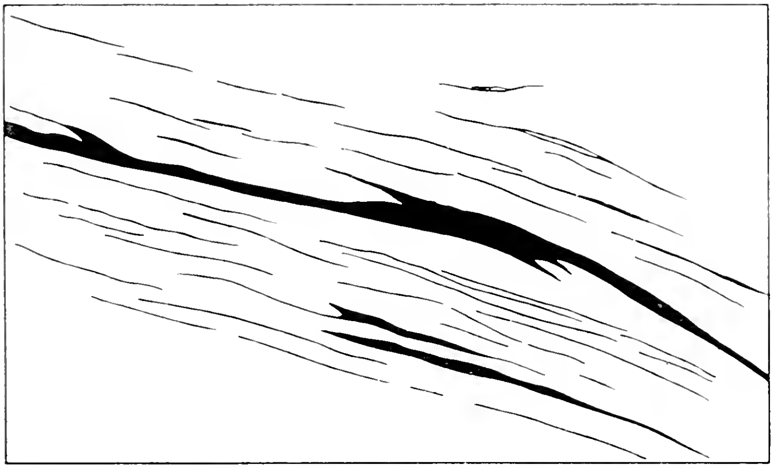

Fig. 36—Sketch showing quartz veins at Howey-Cochenour-Willans gold prospect, Holloway township; east walls at depth of 35 feet in shaft. The length of vein system in sketch is about six feet. The main quartz vein is shown by the heavy black part; parallel stringers of quartz occur on each side of the main vein.

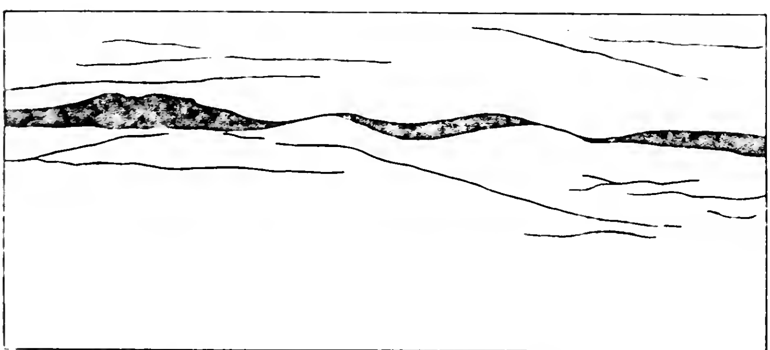

Fig. 37—Sketch showing quartz veins at Howey-Cochenour-Willans gold prospect, Holloway township. Bottom of shaft at depth of 35 feet showing quartz vein in black with more or less parallel quartz stringers.

white quartz. Some plagioclase is also recognized in fractured areas. The gold usually occurs in a fine condition with the pyrite, but samples from the main vein often contain gold in the quartz visible to the eye.

Near the veins the wall rock, which is a basic lava, has been greatly altered by circulating waters to carbonate and chlorite, and is penetrated by veinlets of quartz, calcite and chlorite. The lath-like structure, Fig. 39, in the plagioclase is

well preserved in parts of the wall rock, but the ferro-magnesian mineral is altered to secondary minerals. This alteration decreases away from the veins.

The minerals found in the veins of Holloway and Harker townships are characteristic of veins formed at intermediate temperatures, as described by W. Lindgren in "Mineral Deposits." High-temperature minerals such as tourmaline, pyrrhotite, magnetite or specularite have not been observed in these veins. Some of the quartz in the Howey-Cochenour-Willans vein has crystallized in open spaces in prismatic and rhombohedral forms, indicating a slow filling of the vein. The well defined walls also indicate an open fissure. After solidification the vein was subjected to fracturing with a deposition of considerable calcite and pyrite in the fractured areas of the quartz.

Fig. 38—Section showing granulation of primary quartz. Secondary calcite and pyrite are present. Howey-Cochenour-Willans vein, Holloway township. Magnified about 20 diameters. Cross nicols.

The shaft is reported continued to a depth of about 70 feet, and work was stopped after the rhyolite had been penetrated for 20 feet.

Assays showing the presence of gold in rhyolite have been reported by prospectors from various places along the bands of rhyolite. Some samples taken by the writers have also shown the presence of gold. This rock contains in places considerable iron pyrites and is frequently intersected by minute veinlets of quartz, which may be responsible for the presence of the gold. Being a lava flow, it is unlikely that gold is present as a primary constituent in sufficient quantity to be shown by the ordinary fire assay. Some samples of rhyolite showing no pyrite or veinlets of quartz gave no gold on assay, while others showing these secondary minerals gave assays up to $3.80. We were informed that a number of assays from the rhyolite band south of the shaft on the Howey-Cochenour-Willans property gave an average of $1.50 in gold. This is not surprising, since the rock in many parts carries pyrites and minute veinlets of quartz.

Willans Claim (7248).—Some prospecting has been done on this claim, which lies directly east of the discovery claim (7135) in Holloway township. The rhyolite outcrops at points across this claim, and some portions where work has been done, were found to be heavily mineralized with fine-grained iron pyrites and to contain minute veinlets of quartz. Grab samples from one small pit gave $1.60 and $3.80 per ton. We have since been informed that from another place two samples of mineralized rhyolite over lengths of two and three feet contained $8.00 and $5.00 per ton in gold.

Taylor-Horne Claim (7261).—This claim is located in Holloway township adjacent to the west boundary of the township. Here there is a quartz vein with strike N. 82° E. that can be traced for 125 feet east from the boundary line to

Fig. 39—Basalt wall rock, from shaft at Howey-Cochenour-Willans gold prospect, Holloway township. Magnified 20 diameters. One nicol.

the edge of a bluff rising from the drift. The vein dips 75° S., is narrow, and varies greatly in width. At the easterly exposure it is 8 inches wide where a shallow pit has been made. At another point it is 4 inches in width and well mineralized with iron pyrites, copper pyrites, zinc blende and galena. Some gold was observed at one point in the vein. The enclosing rock is an altered basaltic type. Some selected material from this vein gave on assay $4.40 in gold.

Cochenour, in Harker township (7247).—This claim joins the Taylor-Horne claim on the west side of the boundary line. Work has been done on the strike of the Taylor-Horne vein which towards the west diminishes in width. On the Cochenour claim there is a mineralized zone, but with very little vein quartz exposed. The basalt, which is the country rock, has been greatly impregnated with silica and carbonate solution and iron pyrites over a width of 5 to 10

feet. A little native gold was observed in a joint plane in the altered rock 230 feet west of the boundary.

McDonald Claim (7324).—On the McDonald claim some surface work has been done on three quartz veins in the rhyolite. These veins are from 2 to 10 inches in width and carry iron pyrites and copper pyrites. The most prominent vein which strikes N. 15° E. and dips 75° easterly, has been traced on the surface for 150 feet. Some native gold has been reported from this vein, and values of $8.40 and $7.60 in gold were obtained from selected samples of quartz and rhyolite, carrying iron pyrites.

Fig. 40—Narrow gold-bearing quartz vein, Taylor-Horne claim, Holloway township.

Cragg Claim (7248).—In the southeast part of Harker township there is a band of rhyolite similar to the band which runs through the Perron and McDonald claims about three-quarters of a mile to the north. The rhyolite has been stripped on the Cragg claim in a northeast direction for 230 feet with an average width of 30 feet. The rhyolite is intersected by veins and irregular masses of quartz carrying a small amount of iron pyrites. The rhyolite contains in places pyrite and specularite. Low values in gold from this deposit are reported by Mr. S. Cragg. At the southwesterly end of the stripping the rhyolite is intruded by a minette dike 15 inches in width.

Hurd Claim, L. 7312.—The Hurd claim, L. 7312, is in the southeast part of the township of Harker. The vein of quartz which we saw on this property is from one to eight inches wide, with a strike of north 107° east, magnetic, and a vertical dip. The vein has been traced about 50 feet by trenching, and some blasting has been done. Two samples were taken, both of which were shown by assay to contain no gold. The country rock is a coarse gabbro or diabase.

Perron Claim, L. 7307.—The rhyolite lava flow, which is found at the Howey-Cochenour-Willans prospect, continues westerly and passes through claim 7307 in the southeast part of Harker township. Part of the south side of the flow is rusty on this claim and has had some trenching done on the rusty part. We sampled this rusty portion across a 7-foot section, and an assay of the sample gave $2.40 per ton in gold.

Fig. 41—Rhyolite intersected by quartz, Cragg claim, Harker township.

Gold in Schistose Carbonate Rock.—On the west boundary of Holloway township there is a hill about 10 chains south of the Mattawasagi (Teddy Bear) river. The rock on this hill is schistose and contains much carbonate which is probably ankerite. This carbonate schist was sampled and found to carry 80 cents per ton in gold.

Garrison Township

On the south boundary of Garrison township, about three chains west of the 4-mile post, a small quartz vein, averaging two or three inches in width, strikes north 133° south. The vein is exposed for 100 feet and contains, in addition to quartz, some calcite. A sample of the vein, taken here and there along the strike, gave on assay 40 cents per ton in gold.

At the north end of Garrison township there are several irregular quartz stringers a few inches in width associated with rocks that are partly schistose. These quartz veins are found about an eighth of a mile south of the southwest corner of Rand township, just north of an extensive swamp. One of the quartz veins was sampled and assayed and found to contain no gold. About a mile and a third west of these quartz stringers there is a prominent hill half a mile south of the south boundary of the Abitibi Indian Reserve. On the west side of the hill a small quartz vein a few inches in width was sampled and found to carry 40 cents per ton in gold.

McCool Township

The only evidence of vein formation observed in the Keewatin in McCool township was on the hill in lots 9 and 10 in the second concession, Fig. 3. A few claims have been staked here, but little prospecting has been done.

Gold on Abitibi Lake

Gold was reported on Lake Abitibi by R. W. Coulthard in the Report of Exploration of Northern Ontario in 1900. Later, in 1906, there was a rush to the area and a large number of claims were staked along the shore of the lake and on the islands. The principal discoveries of that time were described by W. G. Miller in the Sixteenth Report of the Bureau of Mines, and by M. B. Baker in the Eighteenth Volume of the same publications. Since that time little has been done in prospecting around the lake.

W. G. Miller [1] gives a description of the gold-bearing deposits on Upper Abitibi lake that occur near the mouth of the Mattawasagi (Teddy Bear) river and easterly to a bay just east of the interprovincial boundary between Ontario and Quebec.

The half dozen deposits examined occur in rock of Keewatin age. These rocks here consist essentially of green schists, which are cut by dikes of fine grained granite or porphyry, varying in width from a few inches to fifteen feet or more. They have been shattered, narrow cracks running across them, characteristically transversely from wall to wall. These cracks are filled with quartz, and there are also at times lenses and irregular masses of quartz, replacing the dike material, or enclosed between it and the wall rock. Fragments of the dikes are frequently cemented by quartz, thus forming a breccia. The dike material is at times changed to sericite schist. The dikes have been impregnated with iron pyrites which is now altered, to a considerable extent, to iron oxide. The pyrites appears to be the gold-bearer. "Colours" can be obtained by panning the dikes, but the highest fire assay from samples taken by us gave only $3.40 per ton. Copper pyrites is at times associated with the iron pyrites.

One of these occurrences can be seen on island 524 S.V. near the mouth of the Mattawasagi river.

In the same report [2] there is a description of a gold-bearing quartz vein on Shaft island, B.C. 173, in Lower Lake Abitibi.

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[1] 16th Report Ont. Bur. Mines, 1907, Part I pp. 219, 220.

[2] Ibid, p. 219.

The auriferous quartz vein on Shaft island varies in width from about four feet to a few inches. It has a vertical dip with strike east and west, and cuts a massive igneous rock which may be called diabase. This rock has a somewhat fresh appearance, and seems to belong to the newer series of eruptives similar to that of the post-Middle Huronian diabase of the Cobalt area. This Abitibi diabase, like that of Cobalt, carries quartz as a characteristic constituent. Iron pyrites together with a little copper pyrites and a dark coloured zinc blende occur in the quartz vein. Fine gold is frequently visible in the quartz. The vein cuts across the island for a distance of over two hundred feet, and disappears into the water on both shores.

Referring to this deposit in a later report M. B. Baker[1] remarks that the diabase cuts the Keewatin, but is intruded by a series of aplitic and also lamprophyritic or dark-coloured dikes. He also draws attention to the similarity of the diabase to that of Cobalt. Diabase of various ages occurs in the Abitibi area. Some of the rather fresh-looking dikes are found to be intruded by feldspar-porphyry dikes that in other parts have frequently been referred to the Algoman age. As the gold mineralization is believed to belong to the Algoman period it is reasonable to think that some of the rather fresh-looking diabases, as at Shaft island, may be pre-Algoman in age.

To the types of gold deposits on Abitibi lake, described by W. G. Miller, M. B. Baker[2] adds two others, namely, quartz veins in granite: and quartz veins and small stringers in a rusty weathering dolomitic rock of Keewatin age. The first of these occurs on the west shore of South bay, near Point 48 A., and the second on the east shore of the lower lake on Point 16 A. Baker states that neither of these deposits is of economic value.

Munro Township and Vicinity

Claims were first staked for gold in Munro in 1908, and work has been going on almost continuously on one claim or other since that time, in and around the southwest corner of the township. A good wagon road connects the locality with the railroad at Matheson. Up to the end of 1918 approximately $260,000 in gold has come from three properties, practically all from the Croesus. The gold-bearing quartz veins occur in sedimentary rocks and Keewatin greenstones which are intruded by an occasional porphyry dike.

The earlier mining was in the sedimentary rocks on long narrow quartz veins, rarely more than a foot in width, which strike slightly north of east and dip almost vertically. Iron pyrites is the chief sulphide; galena and molybdenite occur in lesser amounts and visible gold is present. Such veins were mined previously to 1916 on the following properties: Abate, American Eagle, Munro, Detroit-New Ontario and Gold Pyramid, the latter two having produced a small amount of bullion.

Extremely rich ore was found in the adjacent greenstone to the north in 1914 on the Dobie-Leyson claim afterwards known as the Croesus, which has proved to be the most important property in the area. The vein runs north and south, dips 26° to the east and carries much coarse gold, with considerable pyrite

[1] 18th Report Ont. Bur. Mines, 1909, p. 269.
[2] Ibid, p. 270.

and a little arsenopyrite. In the greenstone on the opposite or southern side of the sediments on the Quinn lot in Hislop township, an interesting gold-bearing quartz vein carrying copper pyrites, pyrrhotite, galena and zinc blende was found in 1918.

Numerous mining locations, few of which are working at present (January, 1919), will be described briefly, commencing with those in the sedimentary rocks.

Abate.—On the Abate claim, lot 4, concession I, Beatty township, there are a number of small parallel quartz veins striking 15° north of east, dipping 80° to the north and conforming to the strike and dip of the country rock, which is greywacké schist. Some quartz stringers cross-cut the intervening schist. Much pyrite, considerable molybdenite and a little visible gold occur in the veins. The Hudson Bay Mining Company did trenching, test-pitting and sampling in 1914, but did not exercise their option.

American Eagle.—On the American Eagle, southeast quarter of south half of lot 10, concession I, Munro township, a shaft was sunk about 75 feet and some cross-cutting done in 1912. The plant was completely burned in 1916.

Detroit New Ontario.—The greatest development on auriferous quartz veins in the sedimentary rocks has taken place at the Detroit New Ontario property where a 100-foot shaft has been sunk and 200 feet of drifting and cross-cutting done on three narrow quartz veins. The main vein strikes east and west and continues intermittently for 1,300 feet to the Guelph shaft: it dips 80° to the south. The vein has a regular width of about 10 inches, and contains pyrite and visible gold in places. Some gold was produced by a small prospecting stamp mill on the property. Work was suspended in August, 1911, and all buildings burned in July, 1916.

Gold Pyramid.—At the Gold Pyramid mine, in lot 11, concession VI, Guibord township, there are two prominent quartz veins in quartzite schist. On the southern of these the development work consisted of a shallow shaft, an open cut, and some trenching in deep soil to the south. The vein, which dips to the south, has been exposed for about 250 feet. The northern vein, which is about 30 inches wide in one place, has been traced for 400 feet, and a shaft was being sunk on it (August, 1911). Pyrite and fine galena are plentiful, with visible gold in places. A 5-stamp mill erected in 1911 has treated considerable ore and produced some bullion. Some ore from the Croesus was treated in the company's mill; but the plant like all the others in the area was completely destroyed by fire in 1916.

Munro Mines.—The Munro mines, locally known as the Guelph, in the southeast corner of lot 11, concession I, Munro township, are entirely in the slates of the sedimentary series. The first operations in the area were at this property, where a shaft was sunk 92 feet on an east and west narrow quartz vein carrying pyrite. Some drifting was done on the 60-foot level, but no further work has been accomplished since 1910.

Buff-Munro.—During parts of 1916 and 1917 the Buff-Munro Mines, Ltd., did some trenching and sank a 40-foot shaft on the Brown veteran lot, the north half of lot 7, concession I, Munro township. William Fairbairn, who was in charge of operations, stated that the vein runs north and south and dips to the east, but in sinking it disappeared at a depth of about 17 feet. Gold and considerable mispickel occur in the deposit.

Burton-Munro.—The Burton-Munro Mines, Ltd., did considerable underground prospecting on the north half of lot 2, concession I, Munro township, in the greenstone, during parts of 1916, 1917, 1918 and 1919. An inclined shaft at an angle of 55° has been sunk 318 feet with stations at the 118 and 300-foot levels. On the first level about 100 feet of work and on the bottom level 735 feet were accomplished. In addition approximately 1,000 feet of diamond-drilling and considerable trenching were done. Camps were rebuilt after the fire of 1916, but mining operations were temporarily suspended in February, 1918. Charles Millar, Toronto, is president.

Fig. 42—Croesus gold mine, township of Munro.

Croesus.—In the spring of 1914 a spectacular gold showing was found on the north central part of lot 10, in the first concession of Munro township, by a prospector named Welsh. When the line was surveyed between the Welsh and adjoining Dobie-Leyson claim, the rich vein was found to be on the latter claim, 15 feet from the Welsh boundary. The Dominion Reduction Company, Ltd., of Cobalt, bought the claim for approximately $75,000 and incorporated it with the Welsh claims, forming the Croesus Gold Mines, Limited. Work commenced in July, 1915, and continued with little interruption until February, 1918, when mining operations ceased. The total production to the end of 1918 amounted to $259,953 in gold and a small amount of silver, coming principally from the upper part of the workings.

The quartz vein, which is about 200 feet long, strikes north and south and dips at an angle of 26° to the east in a fairly massive Keewatin diabase and pillow lava (altered basalt). It is somewhat lenticular in form, and varies

from a few inches in width on the north to a few feet on the south, where it has been cut off by a series of east and west faults. Apparently only a small portion of the vein to the south of the fault has been found. The southerly part has been faulted to the west, as is shown by the occurrence of drag ore in the fault zone on the surface at a point 40 feet west of the vein. Probably the richest ore ever mined in Ontario came from this deposit; 765 pounds of ore taken from a portion of the shaft yielded $47,000 worth of gold. The character of this ore may be seen reproduced in natural colours in the frontispiece of the Twenty-sixth Annual Report of the Ontario Bureau of Mines. Considerable pyrite occurs in parts of the deposit, and fine, needle-like crystals of arsenopyrite often accompany the gold. During the early development a small quantity of ore was treated in the mill on the Gold Pyramid, a mile distant. The disastrous fire of July 29th, 1916, which resulted in a large loss of human lives, destroyed all the buildings in the area and retarded development considerably. New camps were erected, and early in 1917 a 50-ton Hardinge ball mill with amalgamation plates was built.

Development work [1] consists of a 400-foot inclined shaft with the following drifting and cross-cutting: On the 150-foot level 465 feet of drifting; on the 200-foot level, drifting and cross-cutting 208 feet, raising 25 feet; on the 250-foot level, drifting 110 feet, cross-cutting 109 feet, raising 60 feet; on the 300-foot level, drifting and cross-cutting 700 feet, raising 45 feet; on the 400-foot level 100 feet of drifting and cross-cutting.

Quinn.—In the spring of 1918 Neh Falkenham discovered a gold-quartz vein in the greenstones to the south of the sediments on the Quinn veteran lot, north half lot 1, concession IV, Hislop township. He and Alvin Peter optioned the claim and sank an 85-foot shaft on the vein which showed considerable gold in places. The vein, which is from one foot to a few inches in width, dips 85° to the south and strikes east and west for 300 feet where it disappears under drift. Parallel quartz veinlets occur on the hanging-wall side of the vein, while the contact between the vein and the footwall is rather sharp, due to some movement. An enriched streak up to 6 inches in width occurs usually near the faulted, or foot-wall, part of the vein. This richer portion contains much copper pyrites, pyrrhotite, galena, pyrite and some gold in the flour state. On analysis, one or two ounces of silver may also be obtained.

The rocks on the claim comprise alternating flows of basalt largely altered to carbonate and rhyolite, which have been tilted into a vertical position. Only the more basic rocks show the ellipsoidal or flow structures. The acid rocks, rhyolite or porphyry, in which the veins are located, consist largely of white quartz phenocrysts in a fine-grained groundmass of calcite, quartz with some chlorite, and altered feldspars.

Painkiller Lake

Painkiller lake lies 10 miles by wagon road to the northeast of Matheson. Gold was first found in 1907 and 1908, but only desultory mining has been

[1] Ont. Bur. Mines Report, Vol. XXVI, 1917, p. 94; Vol. XXVII, 1918, p. 100.

carried on. Shafts have been sunk 100 feet and mills built, but less than $1,000 in gold has been produced. Interest in the area has been revived at times by the finding of the large gold deposits in Porcupine, 15 miles to the southwest in 1909, and the extremely high-grade ore on the Croesus, 6 miles to the southeast in 1915. The most recent developments have been on the Hill and the Hattie.

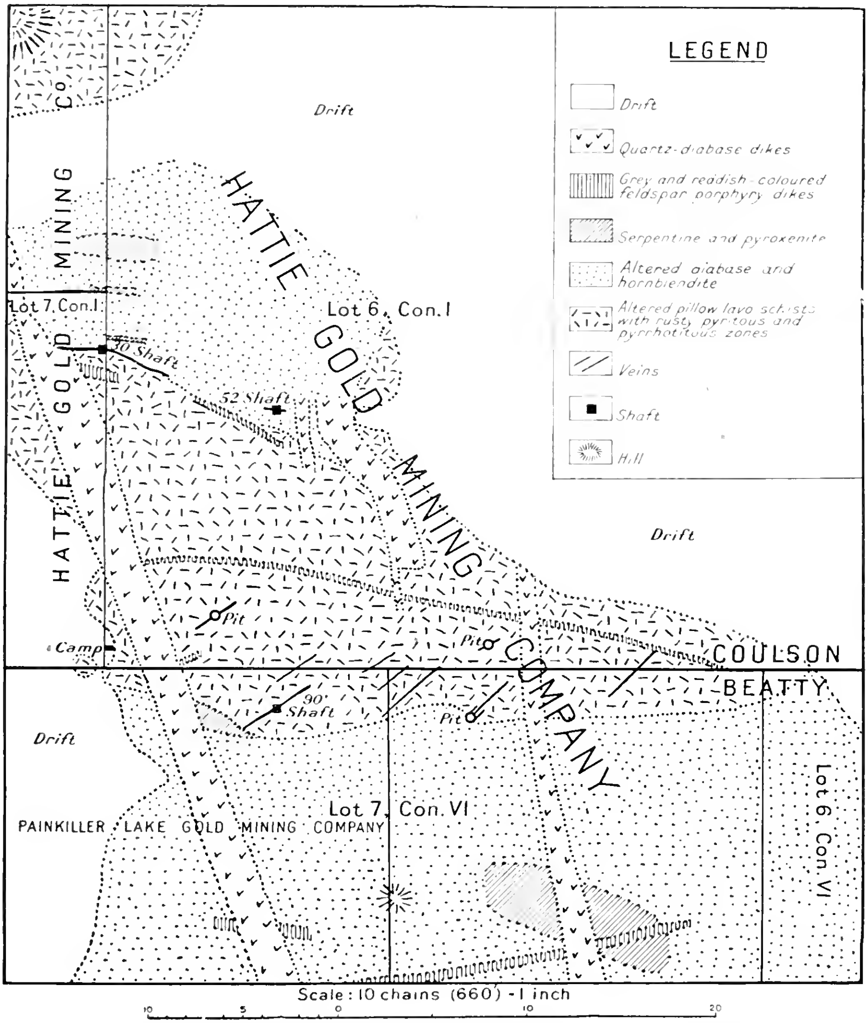

Fig. 42a—Geological sketch map showing properties of the Hattie and Painkiller Lake gold mining companies, townships of Coulson and Beatty.

The mineral veins occur in altered pillow lavas intruded by narrow porphyry dikes; the latter may bear some relation to the origin of the deposits. The numerous, narrow, gold-telluride-quartz veins in the area are practically all parallel and remarkably uniform in direction, northeast and southwest, thus resembling somewhat the parallel veins at Kalgoorlie, but differing from the radial system of fissuring at Cripple Creek, Colorado. They are somewhat of the lode-

formation type, but the veins, which are usually about one inch in width, are not always closely spaced, and the intervening area contains few or no cross-fissures. The minerals are gold, tellurides, pyrite, chalcopyrite, pyrrhotite, galena, zinc blende, quartz, chlorite, sericite and calcite. Large east and west veins of mispickel, pyrite, and quartz carrying low values in gold, silver and copper represent another type of vein.

Cartwright.—The Cartwright Goldfields, Limited, have their main working on the south shore of Painkiller lake on lot 8, concession V, Beatty township. A small quartz vein carrying visible gold, telluride and pyrite strikes southwest from the lake shore under a hill of drift. A 100-foot shaft has been sunk on the hill on the supposed extension of this vein. The shaft was full of water at the time of inspection: however, the dump is composed almost entirely of rock with little vein material. A fire in 1913 destroyed the surface plant, and in 1916 the new buildings and material for a 10-stamp mill were also burned, since which time no work has been done.

Dunlop.—Immediately west of the Cartwright is the Dunlop location. On the east central part of the claim a 20-foot pit has been sunk on an east-west vein of quartz, mispickel and pyrite. At the shaft the vein is 7 feet wide and carries a little gold. Low values in gold also occur in a rusty pyritous and pyrrhotitous greenstone intersected by quartz and calcite stringers on the portion of the claim which projects as a small point into Painkiller lake.

Hattie.—The Hattie Gold Mines comprise several claims in Coulson and Beatty townships. Work has been largely confined to the south half of lot 6, in the first concession of Coulson, and an adjoining part of Beatty township. Development work consists of trenches, test pits and two shafts, the latter being about 40 and 50 feet deep respectively. The veins are in rusty, altered, pillow lava, which has been intruded by hornblendite, peridotite, and serpentine. These peridotite rocks are cut by feldspar porphyry which has in turn been intruded by quartz diabase, as shown on the map. Occurring in the pillow lavas are several pyritous and pyrrhotitous zones, samples from which gave on analysis, nickel, none; platinum, none; and gold, 80 cents. The gold-bearing quartz veins on the property are quite numerous but usually narrow. Most of them are one inch in width and a few hundred feet in length. They strike northeast and southwest and dip from 80° northwest to 80° southeast. The veins contain appreciable amounts of gold and bismuth tellurides, but they are usually too narrow to mine separately at a profit; nor are they often closely spaced, and the intervening parts usually lack in cross-fissures. However, at one point, viz., in the northwest corner of lot 6, concession VI, Beatty township, there are a number of parallel auriferous quartz stringers fairly closely spaced, which may carry milling values over mining widths. At another point, namely, about 350 feet northeast of the Hattie camp, the veins are larger, being a foot or more across, with minute veinlets carrying gold and telluride in the intervening altered rock, the latter being impregnated with much pyrrhotite, pyrite and copper pyrites. At this point high values in gold were reported to have been obtained across several

feet. The tellurides are largely those of bismuth, none of the precious tellurides having been identified.

A quartz vein striking nearly at right angles to the general strike of the veins occurs farther north along the contact between the pillow lava and rocks of the hornblendite-serpentine group. This contact vein which carries gold and telluride averages about six inches in width, and is traceable for 400 feet. A 35-foot shaft has been sunk on the vein, but was full of water at the time of inspection. To the east an inclined shaft has been sunk 50 feet on what may be a continuation of the contact vein. This vein dips 60° to the north, is a few feet in width and carries considerable pyrite and some bismuthinite. J. Papassimakes is president of the company, and E. G. Mayot in charge of the prospecting work.

Hill.—The principal workings of the Hill Gold Mining Company are on the northwest quarter of the north half of lot 11, concession V, Beatty township. Gold was found on the claim in 1915 by a prospector, W. H. G. Parsons, who

Fig. 43—Buildings of the Hill Gold Mining Company, Beatty township, September, 1918.

was burned in the forest fire during the following year. The vein, which is near the northwestern corner of the claim, is composed of quartz and calcite, and varies from a foot to a few inches in width. It strikes northeast and southwest and dips almost vertically. The dip is 80° to the north in the upper 60 feet of the shaft, while in the next 30 feet it is vertical. On the 90-foot level drifts have been run 110 feet to the northeast and 70 feet to the southwest. Pyrite, mispickel and zinc blende are well distributed in the vein. Tellurides are present, and gold can be seen in an outcropping to the northeast of the shaft. The country rock is pillow lava which has been intruded on the adjoining claim to the north by a few narrow porphyry dikes as shown on the map. During the first half of 1918 about 25 men were employed in mining and putting up buildings. A 50-ton Hardinge ball mill was built and a trial sample put through which yielded gold valued at $635. E. H. Williams was in charge of operations. Work was suspended in the fall of 1918, but it is the intention to commence mining again in the near future.

Mayot or Treadwell.—The Mayot or Treadwell claims are the two southern claims in lot 9, concession VI, Beatty township. The veins are quite similar in every way to those on the Hattie, save that they pass from amygdaloidal and ellipsoidal basalt into diabase. No. 2 vein averages from 3 inches to one-half an inch in width, having an occasional branching stringer, and is traceable over a distance of 350 feet. The vein contains much visible gold, tellurides, pyrite and

Fig. 44—Narrow quartz vein carrying bismuth tellurides and gold on Mayot claim; looking northeast across Painkiller lake towards the Hattie mine.

pyrrhotite, and resembles the No. 2 vein of the Tough-Oakes mine, Kirkland lake. There is a 20-foot pit on the northeast end of the vein, the wall rock being a silicified amygdaloidal basalt. To the southeast there are several similar parallel veins which have been exposed by trenching. The wall rocks are extremely hard and tough. No. 1 vein, which is about 4 feet wide at the 32-foot shaft, runs approximately east and west. It consists of a mixture of mispickel

and pyrite, with a little copper pyrites and quartz, and carries some values in gold. A pit has also been sunk on a quartz-calcite vein carrying a little disseminated galena and sphalerite, a sample of which gave on analysis gold, 10 cents; silver, none.

McMaster.—The McMaster claims in lot 9, concession V, Beatty township, lie adjacent to the Treadwell on the south. Some of the veins on the latter extend into the McMaster. Two feldspar porphyry dikes occur on the claim. No work has been done other than trenching and a few test pits.

Painkiller.—The Painkiller Lake Gold Mining Company own the northwest claim in lot 7, concession VI, Beatty township. Extending across the northern part of the claim is a fringe of altered pillow lava rocks, about 150 feet wide, which contains a few gold-bearing quartz stringers, extensions of the veins from the Hattie. The veins are similar to those on the Hattie, and carry gold and tellurides. On one of these stringers a shaft has been sunk 94 feet, but the vein was reported to have disappeared from the shaft at a depth of about 35 feet. Veins have not been found in the hornblendite, serpentine, porphyry and diabase which occupy the greater part of the claim.

Rickard Township

Gold was found in Rickard township in July, 1917, on the Raty claim. Enough underground work was done in the following year to show the ore to be only a small pocket in a large, well mineralized quartz vein. No other gold deposits have been found in the township, which is difficult to prospect owing to the heavy overburden of drift; approximately 97 per cent. of the surface of the township is drift-covered. The depth of these superficial deposits may be judged from the log of a diamond drill hole on the Raty claim which showed 100 feet of drift overlying rock, the hole having been commenced at a point only 25 feet from the outcropping rock.

Raty Claim.—The occurrence of gold on the Raty claim, the southwest quarter of the south half of lot 7, concession IV, Rickard township, has been previously described;[1] hence only a few additional notes will be given. The rocks are pre-Cambrian, consisting of Keewatin volcanics (altered basalts and diabases) with subordinate amounts of banded chert, or iron formation, all of which are intruded by feldspar-porphyry and later by quartz-diabase dikes. The Mining Corporation of Canada, which optioned the property, built camps, installed a steam plant and did considerable underground mining and diamond-drilling. Approximately $110,000 was spent on the property. The late Geo. O. Randolph was in charge of operations, employing at times 50 men. In July, 1918, work was suspended and the claim reverted to the original owners.

Development work consists of approximately 2,000 feet of diamond-drilling, a 100-foot shaft inclined at an angle of 85° to the south, and about 700 feet of drifting and cross-cutting at the 100-foot level. Work has been done on two quartz veins from two to six feet wide, striking nearly east and west astronomically

[1] Report, Ont. Bur. Mines, Vol. XXVII, 1918, pp. 212-214.

and dipping 85° to the south. The veins were found to unite underground at a point a short distance west of the shaft.

In shaft-sinking spectacular ore was encountered between the depths of 5 and 14 feet; the next 25 feet contained milling values, below which gold practically disappeared. The diamond-drill cores showed the veins to be quite extensive, but the values were disappointingly low. The pocket of high-grade ore contained much coarse gold accompanied by bismuth telluride, a lead telluride (?) and other minerals in crushed quartz. Assays showed considerable silver. A sample of the high-grade ore, reproduced in natural colours, may be seen in the Canadian Mining Journal.[1] Sulphides are prominent in all parts of the veins, and they occur usually along dark parallel seams. Pyrite is the common mineral, but copper pyrites, galena and molybdenite are abundant also. Molybdic oxide and native copper are secondary minerals near the surface. Calcite, sericite, chlorite and talc occur usually in seams running through the quartz. For a distance of

Fig. 45—Compressor building and shaft house, Raty claim, Rickard township.

5 to 10 feet from the vein the wall rocks, which were originally pillow lava and diabase, have been altered to a grey or pinkish carbonate rock. Under the microscope the wall rocks are seen to have been replaced largely by calcite and dolomite (?) and partly by quartz, chlorite, sericite and pyrite. Occasionally the faint outline of a feldspar crystal can be recognized. The altered wall rocks are not known to contain any gold values.

Miscellaneous Gold Prospects

In addition to the deposits already described gold has been discovered in other parts of the area. On the O'Neil-Potter claims along the Shallow river in the southeast part of Coulson township low gold assays have been obtained from a quartzite schist which contains much pyrite and thin seams of graphite.

On the Black river at Matheson and about one mile above the town on the

[1] Issue of February 15th, 1918, p. 57.

same river there are narrow quartz veins carrying low values in gold. The rocks are pillow lavas which have been intruded by porphyry.

In the north part of lot 2, concession VI, Carr township, a 6-foot pit has been sunk on a rusty carbonate containing numerous quartz veins. A sample taken from the pit, consisting of quartz, calcite, pyrite and mispickel, yielded on assay \$2.40 of gold to the ton.

Messrs. Critchie and Taylor did considerable prospecting in the southwest part of Wilkie township, where a group of rocks not unfavourable for gold-prospecting have been exposed by the Shallow river cutting through the heavy overburden of clay. The rocks comprise pillow lava, dacite and quartzite, which have been intruded by quartz-porphyry, and finally by diabase. No visible gold has been found, but fair assay values are reported to have been obtained. The writer took a sample, however, from a well mineralized deposit consisting of rusty porphyry schist, quartz and calcite with galena, sphalerite, pyrite and pyrrhotite which was found to contain no gold or silver.

Some prospecting was carried on a few years ago in the southern part of Bowman township, particularly on lots 2, 6, 7 and 8 of concession II. The rocks are hornblende schist and pillow lava intruded by stocks of gabbro and dikes of porphyry, granite, and diabase. On the Turcott claim, southeast quarter of south half of lot 6, concession II, and in the immediate vicinity, there are several narrow veins usually widely spaced, some of which will yield low assay values in gold. Near the south part of lot 2, concession II, on the Campbell-Moore claim, is a vein from one foot to four feet wide, striking east and west and dipping 60° north, which contains low values in gold.

The Silver Foam Mining Company sank a 60-foot incline shaft and a 60-foot vertical shaft on small quartz veins in pillow lava on lot 10, concession II, Walker township, near Monteith. Grab samples from the dumps yielded no gold.

In lots 8 and 9, concessions V and VI, Calvert township, there are numerous narrow quartz veins which carry low values in gold. These occur in pillow lava which is intruded by narrow porphyry dikes. A 4-inch vein of prehnite was identified from this locality.

Messrs. R. S. Potter and G. W. Quinn own the south half of lot 13, concession III, Hislop township. On this lot a pit has been sunk on a quartz vein which contains visible gold.

A one-inch calcite veinlet containing a little zinc blende from Mistogo falls yielded an assay one-half oz. of silver to the ton.

Nickel

Alexo.—The Alexo Mining Company, under the management of William Anderson, is operating a nickeliferous pyrrhotite deposit on lot 1, concession III, Clergue township, extending into lot 12 in the third concession of Dundonald township. Since 1912 ore has been shipped continuously to the Mond Nickel Company's smelter at Coniston, the production to the end of 1918 being 49,132 tons, averaging approximately 4.5 per cent. of nickel and .5 per cent. of copper. An assay made by Ledoux and Company on a parcel of between 5,000 and 6,000 tons shipped in 1915, showed 0.03 oz. of platinum and palladium per ton of ore.

The pyrrhotite occurs as lenses from 3 to 40 feet wide in a serpentine-andesite contact. The deposits have been described in detail by A. P. Coleman,[1] W. L. Uglow,[2] M. B. Baker,[3] and in the report of the Royal Ontario Nickel Commission.[4] The present workings are at a depth of 350 feet.

Other Nickel Occurrences.—Some disseminated and massive nickeliferous pyrrhotite has been found to the southwest of the Alexo mine, along similar contacts, on the Troop, Chisholm, O'Connor and Mond Nickel Company's claims.

M. B. Baker also refers to a similar occurrence in lot 7, concession V, McCart township, belonging to D. O'Connor and J. A. McAndrew.

Alex. Kelso[5] stated that low-grade nickel ore has been known for some time at South bay, Night Hawk lake, in Carman and Langmuir townships.

A pyrrhotite vein, three feet wide, in lot 5, concession VI, Beatty township, contains traces of nickel and 40 cents of gold to the ton.

In lot 12, concession III, Munro township, Chas. Mickle has sunk a 50-foot shaft on a massive pyrrhotite deposit 5 feet wide, a sample from which yielded on assay, nickel 1 per cent.; gold, none; platinum, none. Like most deposits, it occurs at the contact of a pillow lava and altered diabase or serpentine.

Near the centre of lot 5, concession V, of the same township, Messrs. Burk and R. Reid own a deposit which is said to carry appreciable amounts of nickel and copper.

At the north end of Garrison township a little over an eighth of a mile south of the southwest corner of Rand township and at the north edge of a great swamp, there is a dike of serpentine rock which was tested for nickel and platinum. A qualitative analysis showed the serpentine to contain a trace of nickel and no platinum. At the southwest corner of Rand township there is a precipitous hill of grey, acidic lava which is at times amygdaloidal. On some faces of this steep hill the rock is rusty, the rusty material evidently weathering from pyrrhotite. A few fresh specks of the pyrrhotite were found and submitted to a qualitative test for nickel, which showed that the pyrrhotite carried no nickel. On the south and north sides of this hill there are dikes of serpentine rock.

Chromite

Serpentine rock containing chromium was first found on Lower Lake Abitibi in 1873 by Walter McOuat.[6] Later M. B. Baker, in 1908, found a serpentine rock containing chromium about the middle of the east shore of Northeast bay in Lower Lake Abitibi, just south of point 16 A. The chromium contents of this rock, however, are too small to be of economic importance at the present time.[7]

William Campbell of Low Bush sent to the Bureau of Mines in 1918 a

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[1] Ont. Bur. Mines, Vol. XVIII, 1909, Pt. I, pp 23-24; Econ. Geol., Vol. V, 1910, pp. 373-376; Dept. of Mines, Can., "The Nickel Industry," 1913, p. 112.

[2] Ont. Bur. Mines, Vol. XX, 1911, Pt. II, pp. 34-38; Journal Can. Min. Inst., Vol. XIV, 1911, pp. 657-677.

[3] Ont. Bur. Mines, Vol. XXVI, 1917, pp. 258-274.

[4] Royal Ont. Nickel Commission Report, 1917, pp. 228-232.

[5] P. 23, Appendix, Report of Royal Ontario Nickel Commission, 1917.

[6] Geol. Sur. Can., 1872-3.

[7] Ont. Bur. Mines, Vol. XVIII, 1909, pp. 273-5; Vol. XXVII, 1918, pp. 205-6.

sample of serpentine from point "1A" on Lower Lake Abitibi which is about four miles southeast of the outlet of the lake. The sample was found to contain 0.82 per cent. Cr_2O_3, no platinum and no nickel.

The serpentine at Lightning mountain in the south part of Frecheville township was tested for chromium and platinum, the tests giving negative results. The occurrence of serpentine on Lightning mountain is more fully described on page 66.

The occurrences of chromite in Reaume and Dundonald townships are referred to in the Twenty-seventh report of the Ontario Bureau of Mines on pages 206-208.

Several samples of serpentine from various parts of Mann township were found to contain no nickel or platinum.

Fig. 46—Veinlets of asbestos in serpentine, lot 6, concession 1, Warden township.

Iron Pyrites

Iron pyrites has not been shipped from the area: however, there are two or three prospects which may be mentioned.

William Campbell of Low Bush P. O., Ont., is interested in a deposit of iron pyrites on the shore of Lower Lake Abitibi on lot 4, concession C, Steele township. On the shore there is much gossan and considerable pyrite disseminated through a graphitic schist. Mr. Campbell states that under the water the pyrites is practically pure over a width of eight feet. This was not seen owing to the water in Abitibi lake having been raised nine feet by the building of a temporary dam at Couchiching falls.

In 1916 Dan O'Connor discovered an interesting and somewhat unique deposit of iron pyrites on lot 7, concession V, McCart township. This is described by M. B. Baker [1] as follows:—

[1] Ont. Bur. Mines Report, Vol. XXVI., 1917, p. 272.

Scattered through the ash-rock or tuff are small round ball-like concretions of iron pyrites. They vary in size from that of peas, to balls two inches in diameter. In places there is a layer six feet or more in thickness, where these ball-like concretions are so packed together as to be almost touching each other. It is the writer's belief that below water level this pyrites would tend to become massive, and if so, would form a possible source of the sulphide for the extraction of sulphur dioxide, so much needed in the wood pulp industry of northern Ontario.

D. O'Connor and J. A. McAndrew tested the deposit at depth by diamond-drilling, but found the pyrite to be disseminated through the rock and not massive over mining widths.

Asbestos

Asbestos occurs as minute veinlets in many serpentine outcrops in the map-area, but no economic deposits have been discovered as yet. Asbestos, however, was shipped in 1916-17 from the Slade-Forbes claim, H.R. 368, Deloro township, which lies only 6 miles west of the map-area. Portions of this serpentine carry 12 per cent. of asbestos veins and much of the fibre is two inches in length and of good quality.[1] Prospecting some of these serpentine areas for asbestos might meet with success. One of the most favourable showings is on lot 8, of the fourth concession of McCool township, where there is fibre one inch in length. Another interesting occurrence is on lot 8 of the second concession of Munro township, where there is a network of asbestos veins, much of the fibre being over half an inch in length. Numerous minute veinlets of asbestos were seen in the serpentine on the line between lots 6 and 7, concession I, Warden township. The asbestos stringers, some of which are half an inch in width, occupy a large portion of the rock covering an area of 50 feet by 300 feet. A few asbestos seams rich in magnetite occur in the serpentine near the middle of concession II, between lots 6 and 7, Munro township.

Unusual Magnetic Declination in Frecheville and Rand

Along the south boundary of Frecheville township the compass was found to have an unusual variation at and near the contact of an intrusion of serpentine which cuts Keewatin lava. The Keewatin here forms a prominent hill known as Lightning mountain, about two miles east of the southwest corner of Frecheville township. At the foot of Lightning mountain, on the southwest side, the mass of serpentine referred to strikes about west 30° north. The greatest variation, which is 95° west of the true astronomic north, occurs at about the contact of the serpentine and Keewatin, Fig. 47. It is evident that the variation is due to the serpentine rock, since it falls as one leaves the contact, Fig. 47. The only apparent cause for this unusual declination appears to be the presence of a very little magnetic in the serpentine. Analyses of the serpentine for platinum, chromium or nickel gave negative results.

There was also found a heavy magnetic declination along the south boundary of Rand township in a swamp. The declination is as high as 36° west of north astronomic. The south boundary of this township being drift-covered, it was not

[1] Ont. Bur. Mines Report, Vol. XXVI., 1917, pp. 108, 273-4.

possible to discover the cause of the declination. However, there is an iron formation about a mile south of the boundary. If this extends north, below the drift, it probably would account for the variation of the compass.

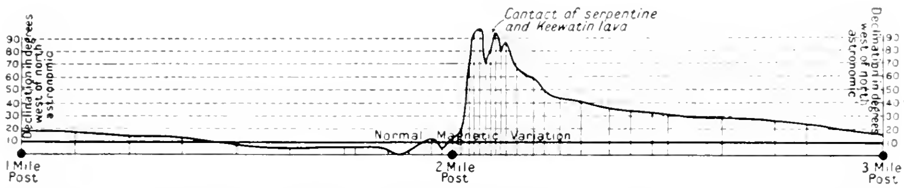

Fig. 47—Curve showing unusual magnetic declination at and near the contact of serpentine rock and Keewatin lava, at the second mile post on the north boundary of Holloway township south of Upper Lake Abitibi. Proceeding east along the serpentine rock the declination suddenly rises to 98° about the contact of serpentine and Keewatin. On leaving the serpentine and entering the Keewatin, the declination very gradually falls to normal proceeding east away from the contact.

Sand, Gravel and Clay

Much of the sand and gravel of the area has been of value for railway ballast, road dressing and construction purposes. Enormous quantities of gravel were taken from the Nellie Lake pits to build the railway across the swampy flats to the north. Gravel has been loaded into scows at the mouth of the Shallow river

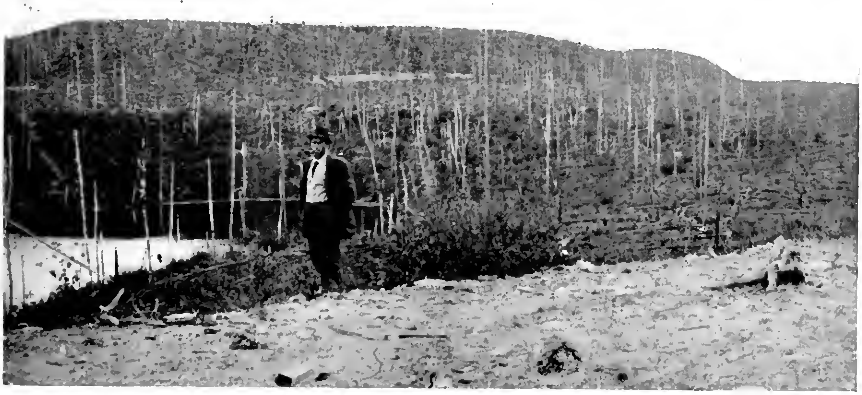

Fig. 48—Morainic hills at Nellie Lake, with a kettle lake in the foreground.

and taken down stream for the construction of the dam at Iroquois falls. The same has been done where the morainic ridge crosses the Abitibi river in Teefy township for the dam at Twin falls. Wherever convenient, gravel is used on wagon roads.

Clays suitable for brick-making are plentiful.

Waterpowers and Hydro-Electric Plants

J. G. McMillan in his report[1] on "Explorations in Abitibi" describes the various waterpowers of the region. What Mr. McMillan asserts is the most easily developed waterpower, viz., High falls on the Frederick House river, Mann township, with a drop of 46 feet, has been destroyed, as described elsewhere on page 42. The river has worn back three miles and formed a 10-foot falls from which a small power could be developed. Five miles below the old 'High falls' is a drop of about 30 feet in a distance of three-quarters of a mile which could be utilized for power purposes by constructing a dam about 200 feet in length near the foot of the rapids.

Iroquois falls, on the Abitibi river, in the fourth concession of Teefy township, has been developed by the Abitibi Power and Paper Company. Approxi-

Fig. 49—A residential portion of Iroquois Falls, 1918.

mately 19,000 horse-power is utilized by the company to operate its plants and to light the town of Iroquois falls. The head varies from 42 to 45 feet, and the drainage area is 5,278 square miles.

This company is also developing Twin falls, 4½ miles east of Iroquois falls on Abitibi river. The power-house will have four units operating under a head of 55 feet and using 4,500 cubic feet of water per second. This dam will maintain the river above at the level of Abitibi lake, thus drowning out various rapids and also the 15-foot drop at Couchiching. The area along the river which will be flooded is shown on the map by solid lines. Construction work at Twin falls was suspended temporarily in 1917, the foundations of the dam being well under way at the time. When the plant is complete power will be sold for various purposes.

The Ontario Hydro-Electric Power Commission has developed a small power on the Driftwood river at Monteith for the purpose of lighting this town. The town of Cochrane is lighted by electricity furnished by producer gas engines.

[1] Fourteenth Report, Ont. Bur. Mines, Vol. XIV, 1905, Pt. I, p. 208.

Fig. 50—Abitibi Power and Paper Company's plant at Iroquois Falls, 1918.

Pulp and Paper Mills

The Abitibi Power and Paper Company, Limited, is operating at Iroquois falls one of the largest pulp and paper mills in Canada. During parts of 1918 about 15 cars of paper were shipped daily. Power is supplied by the company's hydro-electric plant at Iroquois falls. Additional power, as already mentioned, is being developed 4½ miles east at Twin falls.

The timber limit, which comprises 1,560 square miles, is ideally situated, being well traversed by navigable waters and two lines of railway.

In the manufacture of sulphite pulp elemental sulphur is imported from Louisiana, the daily consumption being about 2,650 pounds; the limestone comes from Haileybury.

If the pulp and paper industries in Ontario would exchange native sulphur for pyrite, the iron pyrites industry would be benefited.

Bibliography

The area included in the map, accompanying this report, has been frequently referred to by geologists and explorers who have at various times made detailed examinations of small areas or exploratory trips through parts of the region. This is particularly true of the westerly part, where repeated references are made to the country in the vicinity of the Abitibi river and its tributaries, the Black and Frederick House rivers. There are also a few such references to the geological and other features of the country directly around Abitibi lake. Otherwise little was known regarding other parts of the region. In the following list of reports additional information relative to this area may be obtained.

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LARDER LAKE GOLD AREA

By P. E. Hopkins

Introduction

During the first week in October 1918 the writer examined the working properties at Larder Lake. A brief history and geological summary of the camp will be given prior to describing the working properties, the hydro-electric development, and a pyrite deposit which was discovered by the writer in Hearst township. The properties mentioned in the report are shown on the accompanying map, Fig. 1. Many thanks are due C. G. Dampreé and members of the Larder Combined company for courtesies extended to the writer. The drawing accompanying the report was made by W. J. Bell of the Bureau of Mines.

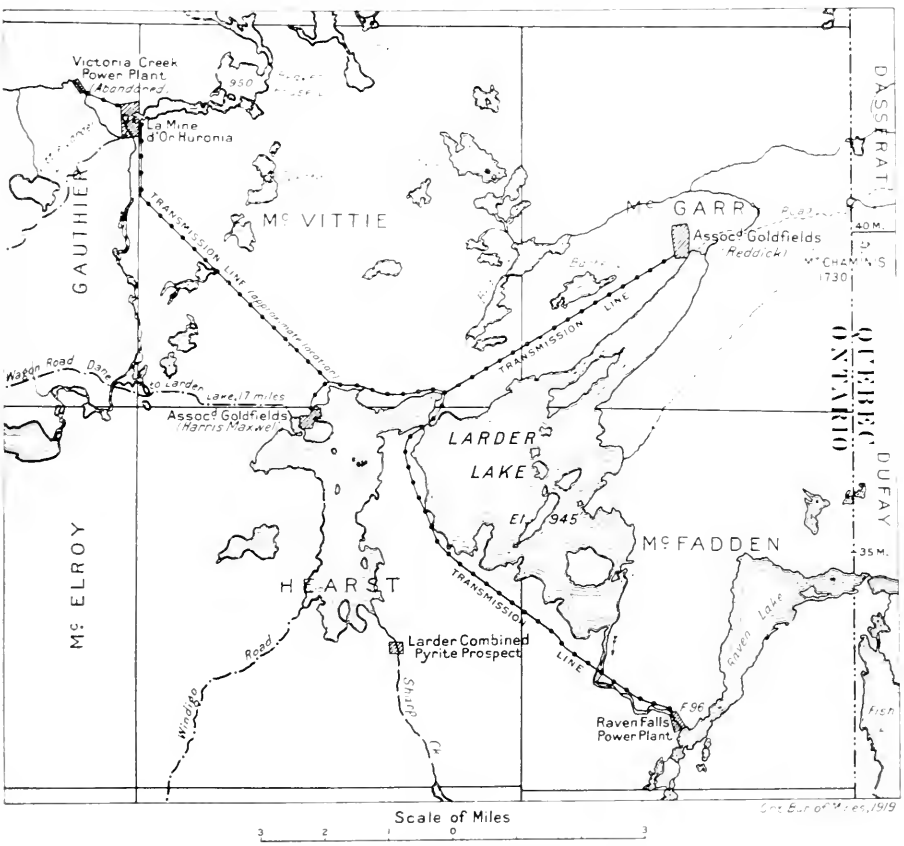

Fig. 1—Sketch map of the Larder Lake Mineral Area, showing locations of transmission lines, power plants and certain mining properties.

Location and History

Larder lake is situated 50 miles due north of the Cobalt silver area, near the Ontario-Quebec boundary. It is connected by a wagon road 17 miles in length to Dane station, which is at mileage 160 on the Timiskaming and Northern Ontario railway. The road is used by automobiles in the dry summer weather.

The finding of gold at Larder lake in August, 1906, by Dr. Reddick, caused a rush of prospectors to the area during the following winter of 1906-07, when a few thousand claims were staked. In June, 1907, the Larder Lake Mining Division was formed and J. A. Hough appointed Mining Recorder at Larder City. Development and prospecting following the "winter stakings" resulted in much disappointment, as is often the case, and hence most prospectors left the area, and the recording office was moved to Matheson in March, 1911. Desultory mining has been carried out at two or three properties since. The total gold production is in the neighbourhood of $20,000, coming from the Associated Goldfields (Harris-Maxwell), Mine d'Or Huronia and Reddick. The writer did not have access to assay plans or do any extensive sampling. However, from what was learned there are parts of the area in which recent development work has made certain properties more promising.

Literature

In 1901 Dr. W. G. Miller,[1] Provincial Geologist of Ontario, passed through Larder lake, then called Lake Present. In 1903 Dr. W. A. Parks,[2] of Toronto University, described the geology along the chief waterways of the area. In June, 1907, R. W. Brock,[3] who afterwards became Director of the Geological Survey of Canada, examined and reported on an area in the vicinity of Larder lake for the Ontario Bureau of Mines, his report being accompanied by a geological sketch map. His assistant, N. L. Bowen,[4] continued geological work during the remainder of the summer and published a more detailed map and a brief report. M. E. Wilson,[5] spent 1908 and 1909 in the area, and has published the most detailed maps and reports on the area. During 1912 and 1913 A. G. Burrows and P. E. Hopkins examined from the Kirkland Lake and Swastika gold areas eastwardly to La Mine d'Or Huronia.[6] In September, 1916, A. G. Burrows[7] examined La Mine d'Or Huronia and a part of Gauthier township.

Geology

The geology of Larder Lake is similar to the pre-Cambrian in many other parts of Ontario. The oldest rocks are dominantly volcanics, comprising greenstones and green schists. Associated with them are bands of ferruginous carbonate, iron-formation, slate, and conglomerate, which strike nearly east and west, and dip vertically. The sediments have their greatest development along the north shore of Larder lake, portions of which are traceable westerly to Kirkland lake. The rusty-weathering carbonate at Larder lake is intersected by quartz and

[1] Lake Temiskaming to the Height of Land, by W. G. Miller, Ont., Bur. of Mines Report, 1902, pp. 214-230.

[2] The Geology of a District from Lake Temiskaming northward, by W. A. Parks, Summary Rep. G.S.C., 1904, pp. 198-225.

[3] The Larder Lake District, by R. W. Brock, Ont. Bur. of Mines Report, 1907, pp. 202-220.

[4] Ont. Bur. of Mines Report, 1908, pp. 10-11.

[5] Larder Lake and Eastward, by M. E. Wilson, Summary Report, Can. Geol. Surv., 1909, pp. 173-179. Geology and Economic Resources of Larder Lake, by M. E. Wilson, Memoir No. 17-E., Can. Geol. Surv. 1912.

[6] Kirkland Lake and Swastika Gold Areas, Ont. Bur. of Mines Report, 1914, Pt. 2.

[7] Gold in Gauthier township, by A. G. Burrows, Ont. Bur. of Mines Report, 1917, pp. 252-257.

calcite stringers which carry most of the gold in that area, and will be mentioned later in greater detail. Cutting the above rocks are dikes of porphyry and aplite, presumably from the large granite batholith to the southeast. Lying on the above rocks are erosion remnants of conglomerate, greywacké and arkose of the Cobalt series. The diabase and gabbro dikes represent the latest igneous activity and are the youngest rocks of the area.

Rusty-weathering Carbonate (Gold-bearing Formation).—Rusty carbonate rocks are found in or near many of the gold areas of northern Ontario. This type of material has been prospected to a considerable extent in various parts of Ontario without yielding any producing gold mines. These rocks are more widely distributed in Larder Lake than elsewhere, and are important since they appear to contain a greater quantity of gold than the other rocks of the area. Gold, however, does occur in the aplite on the Gold King and in the porphyry and green schists of La Mine d'Or Huronia. It is believed that the gold is related to these aplite-porphyry intrusions and, therefore, indirectly to granite. The rusty-weathering carbonates are in places dolomites which occur in bands up to 300 or more feet in width. They are usually brown in colour, but often large parts of them have been altered to green fuchsite or mariposite, serpentine and talc. They are intersected by a network of quartz and calcite stringers which carry low assays in gold over considerable widths and frequently contain small ore shoots or spectacular gold showings. Although this association of rocks and mineral solutions is not known to form ore in many parts of the world, still there is a resemblance to the ore bodies on the Rawhide mine, southeast of Angels Camp, California. Small, medium-grade ore shoots do occur, as on the 83-foot level of the Reddick and 500-foot level of Harris-Maxwell, but they are isolated, with little to indicate where they will be found, and what will be their extent. The passing from ore into material altogether or nearly barren is indicated only by the disappearance of visible gold and by low assays, not by any change in character of the deposit. Since the known richer shoots are small and scattered, the success of mining will depend upon the working of extremely large bodies of low-grade ore, which will necessitate much capital and very detailed mining. Electric power being available, a careful systematic surface sampling can be made of large areas of mineralized dolomite at a reasonably small cost, with the view of locating low grade ore over considerable width.

Associated Goldfields

The Associated Goldfields Mining Company, Limited, is operating Block "B" and Block "D," formerly known as the Harris-Maxwell and Reddick mines respectively. Power is supplied from the company's own hydro-electric plant at Raven falls, all three properties having telephone connection. The officers of the company are as follows: Geo. A. Mackay, president, C. G. Dampreé, general superintendent, and D. A. Anderson, electrical engineer.

Raven Falls Hydro-Electric Power Plant.—The power station is situated on Raven lake, at the entrance of Raven river. Larder lake serves as a storage basin.

The water is led through a flume 6 feet in diameter and 1,280 feet long, and the turbines operate under a head of 96 feet. According to A. R. Webster, Mining Inspector for Ontario Bureau of Mines, two horizontal turbines of 800 h.p. each run two 700-k.w. generators. The voltage is stepped up from 2,400 to 13,200 through three transformers of 300 k.w. each. Power is then transmitted 7¾ miles to "the Narrows" on Larder lake, where the line divides, one branch going 4½ miles northeasterly to the Reddick, and the other 2½ miles westerly to the Harris-Maxwell and an additional 5½ miles northwesterly to La Mine d'Or Huronia, making in all about 21 miles of transmission line (three phase, sixty cycle), as shown on the accompanying sketch map. At the Reddick the voltage is stepped down to 2,200 through two 150-k.w. transformers. Here a 225-h.p.

Fig. 2—Face of drive on 500-ft. level, Associated Goldfields (Harris-Maxwell) property, in ore containing visible gold.

motor drives a compressor of 2,000 cu. ft. capacity. The branch line to the Harris-Maxwell is stepped down through two 75-k.w. transformers to 550 volts. On the property there are motors for driving the various machinery units. Power was supplied for a time for the running of the mill on La Mine d'Or Huronia. The latter had a small electric plant of its own on Victoria creek, but it was closed owing to lack of storage capacity.

Block "B" Associated Goldfields (Harris-Maxwell).—This property consists of two claims, H.S. 114 and 115, on the northwest shore of Larder lake. An inclined shaft has been sunk to the 65-foot level where drifts and cross-cuts have been run, and a raise connected with the open pit. From the open pit level a vertical shaft or winze has been sunk to the 500-foot level, stations having been put in at each 100 feet in depth. On the 500-foot level about 150 feet of drifting and cross-cutting have been done. The openings are all in silicified dolomite,

with the exception of a narrow trap dike occurring in the inclined shaft or tramway to the mill. A 10-stamp mill was built in 1908, and a few trial runs made by the Harris-Maxwell and Lucky Boy Mining Companies. The last mentioned had the property under option for two months in 1909. An additional 30-stamp mill was built in 1912, and completed early in 1913, under management of E. T. Brooks, and was run by electricity supplied from the Raven Falls hydro-electric power plant, which was completed at about the same time.

Desultory mining has been going on since operations began. In the early days, according to M. E. Wilson, a shipment of 1,500 lbs. from an open cut was sent to the School of Mining, Kingston, and yielded $13.20 to the ton. A mill run of 230 tons from the same open cut made by the Lucky Boy Mining Co. in 1909 averaged only 15 cents to the ton. A mill run from another surface showing gave $2.20 per ton.

In 1913 a production was reported to the Ontario Bureau of Mines from

Fig. 3—Gold-bearing quartz stringers in dolomite (not necessarily ore). Open pit at Associated Goldfields (Harris-Maxwell), with Larder Lake to the east in the distance.

ore put through the mill from shaft sinking. To a depth of 440 feet the workings are largely in grey dolomite while below this the rock is quite green, being rich in fuchsite, and cut by quartz stringers which carry much tourmaline and pyrite, the quartz at times being a few feet in width. On the 500-foot level a drive was run into 10 feet of this material containing visible gold, some of which is quite coarse. Mr. Mackay reported that the drive was continued for an additional 20 feet in similar rich ore. The size of this ore shoot has not as yet been determined. The gold, some of which is quite pale in colour, suggesting the presence of silver, is usually accompanied with much fine galena. The plant, which is equipped with various motors, consists of a 10-stamp mill with crushers, amalgamation plates, Wilfley tables, hoists, compressor, saw mill, planing mill, and car-

penter shop. The mill is not running at present. The company is contemplating building a more suitable and larger mill. Forty men were employed on the property on October 1st.

Block "D" Associated Goldfields (Reddick).—The Dr. Reddick, the pioneer property in the area, consists of two claims, H.J.B. 29 and 30, on the northeast arm of Larder lake. The gold deposits are on the former claim and there is a 20-stamp mill, not in use, 1,000 feet distant near the lake shore on the latter claim. This is the property on which gold was first reported to have been found at Larder lake. The rocks consist of alternating bands of dolomite and green schists, of which probably the most are sediments, striking approximately east and west and dipping 70° to the north. The dolomite contains a network of quartz veins, some of which have coarse gold showings.

Development work consists of a 90-foot shaft with approximately 725 feet of lateral work on the 83-foot level, and numerous open pits. The mining plant consists of a 225-h.p. motor which drives a compressor of 2,000 cu. feet capacity and an abandoned 20-stamp mill. A run of about 100 tons from an open pit was put through the amalgamation mill in 1908 and a small production recorded. According to M. Ogilvy, then in charge, this ore carried $10 to $12 of gold to the ton. On further exploration by H. P. Depencier a drive of 350 feet long at the 83-foot level was made under the large open-cut, all of which was in material carrying little or no gold. In the summer of 1911 development work was renewed by cross-cutting at the 83-foot level in the opposite direction in the hope of ascertaining the extent of a second surface gold showing. At a distance of 62 feet from the shaft an ore body was encountered which is 20 feet wide and is said to run approximately $10 of gold per ton. A small stope was made and some ore milled by amalgamation between July and October, 1911, after which time no work was done until the Associated Goldfields bought the property in August, 1917. Since then an electric transmission line has been built, and the stope on the 83-foot level has been extended until it is approximately 250 feet long, 20 feet wide in the centre, tapering at the end, and 25 feet high (October, 1918). At that time gold could be seen in different parts of the top of the stope. The gold usually occurs in a fine-flour state with iron pyrites and some copper pyrites and native copper, along dark seams of chlorite, calcite, fuchsite and other minerals. There is no trouble in finding samples containing visible gold on many parts of the dump. Much additional development work will be done on this property.

La Mine D'Or Huronia

Gold was found in 1912 on claims L. 2586 and L. 2587, on the west shore of Beaverhouse lake, in Gauthier township. These claims were taken up by La Mine d'Or Huronia and have been worked intermittently ever since, except in 1915, when an extensive examination was made of the property by A. Paré for N. A. Timmins who had it under option; the option, however, was not exercised. A. G. Burrows describes the quartz veins as being narrow and striking northeast in a greenstone cut by quartz porphyry dikes. Gold is visible, accompanied by iron pyrites, copper pyrites, magnetite and calcite. Gold also occurs in veinlets

in the porphyry. Development work consists of numerous test pits, approximately 1,000 feet of underground work and considerable diamond drilling. The plant comprises a 15-stamp mill, a tube mill, Dorr classifier, 3 concentrating tables, 2 slime tables and a cone classifier. Power was supplied for a time by the company's hydro-electric plant on Victoria creek, $\frac{3}{4}$ of a mile distant, but owing to scarcity of water the plant could not be operated for long. By December 10th, 1915, a transmission line was completed from the Associated Goldfields and ample power obtained. The mill ran part of 1916 but the property was closed on December 2nd of that year, and total gold production being in the neighbourhood of $9,165. Operations were again resumed at the end of 1918.

Other gold prospects worthy of mention upon which some work has been done are Gold King, Chesterville, Kerr-Addison and Larder Lake Proprietary.

The tourmaline at the Harris-Maxwell and the magnetite on La Mine d'Or Huronia suggest that the deposits were formed at a high temperature and pressure and at a great depth.

Iron Pyrites

A promising pyrite prospect occurs on claim H.S. 904 or No. 2717 on Sharp Creek, one-half mile from the southwest bay of Larder lake, in Hearst township. This is one patented claim of a group owned by the Combined Larder Mines, Ltd., in which James Hales, Barrister, Imperial Bank Building, Toronto, is interested. The claims were extensively prospected near the surface for gold several years ago, but apparently with little success.

In October, 1918, the writer while examining some of the old workings noticed that a mineral dump on the above claim, H.S. 904, consisted almost entirely of massive iron pyrites with some gossan. The shaft was full of water but the owners reported it to be 25 feet deep with a 25-foot cross-cut at that depth, the workings being in pyrite. The dump consists mainly of fine-grained massive pyrite with occasional quartz and dolomite stringers carrying a little pyrrhotite and magnetite. An eight-pound sample, which was fairly representative of the dump yielded on analysis, 43 per cent. of sulphur and 40 cents of gold to the ton. About 100 yards northwesterly from the dump with intervening drift-covered surface is a deposit of "sugary quartz" and 100 yards further along the same strike is a 30-foot shaft in a banded formation of similar quartz with much pyrite and pyrrhotite. The rocks in the vicinity are dominantly green chlorite schists and pillow lavas. The deposit is apparently worthy of further development. It lies 12 miles distant from the Timiskaming and Northern Ontario railway, and $1\frac{1}{2}$ miles from the Associated Goldfields hydro-electric transmission line.

Massive iron pyrites several feet wide was also seen at a 6-foot pit on Claim H.S. 913 in the southeast part of Hearst township.

END OF PART II.

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